Appendix A:
Press Releases and Speeches

GOVERNOR PATRICK SIGNS REGIONAL PACT TO REDUCE GREENHOUSE GAS EMISSIONS

Auction of emissions allowances will fund energy-saving programs to lower electricity bills and further reduce emissions

Boston- Thursday, January 18 - Governor Deval Patrick today signed the Regional Greenhouse Gas Initiative (RGGI), committing the Commonwealth of Massachusetts to a multi-state effort to reduce emissions of carbon dioxide and tackle global climate change.
At the signing, Governor Patrick also pledged to use the proceeds of the sale of emissions allowances to fund an aggressive program of energy savings for households and industry. In addition, he will prioritize the purchase of renewable energies for state agencies.

"Today, my Administration takes its first step to set Massachusetts on a new course toward a clean energy future," said Governor Patrick. "Joining this pact and using the auction proceeds to fund an aggressive new energy-efficiency and peak-management initiative will pay dividends in three ways: We curb our greenhouse gas emissions, we create new economic development opportunities and we cut our energy costs."

"Changes in the electricity market are creating new economic incentives for large scale energy efficiency initiatives and programs that cut electricity demand on peak days - the hottest days in the summer when lots of us are using air conditioners," said Secretary of Environmental Affairs Ian Bowles. "The Governor wants to use these incentives - along with those created by RGGI - to drive down greenhouse gas emissions, drive down electricity costs, drive up energy efficiency, and strengthen reliability of the power system."

The Regional Greenhouse Gas Initiative is an effort undertaken by Northeast states to develop a market-based system for reducing carbon dioxide (CO_2) emissions from power plants. On terms reached in December 2005, seven states - Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont - signed a Memorandum of Understanding (MOU) to participate in the RGGI system. Massachusetts - which had been involved in the development of RGGI - declined to sign the agreement at that time, as did Rhode Island.

At a briefing with climate scientists and the CEOs of Bay State energy-technology companies held today at the University of Massachusetts-Boston, Governor Patrick heard about the rising threat of climate change and how technologies developed by Massachusetts entrepreneurs can combat global climate change, provide savings to electricity consumers, and create jobs at the same time.

Following the briefing, Governor Patrick signed the RGGI MOU on behalf of the Commonwealth, as well as letters to the governors of the other RGGI states announcing that Massachusetts had rejoined the regional effort.

"Climate change is one of the most pressing challenges of our time," said Governor Patrick. "On this day, we want everyone to know that Massachusetts will not stand on the sidelines."

"The challenge of climate change illustrates vividly the need to integrate energy and environmental policy," added Governor Patrick, who has begun a sweeping Cabinet reorganization that combines energy and environmental affairs agencies into a single secretariat.

Under RGGI, annual emissions of CO_2 in Massachusetts from power plants of 25MW and larger will be capped at approximately 26 million tons statewide from 2009 through 2014, then reduced incrementally by 2.5 percent per year for the next four years. Under this cap, each state is given "allowances" for its emissions. Electricity generators will need an allowance for each ton of CO_2 they emit. Each state has discretion as to the manner by which it distributes these allowances. It can allocate them to generators for free, based on their past role in the energy marketplace, sell them by auction, or do a combination of the two - except that RGGI stipulates that at least 25 percent of allowances be allocated "for a consumer benefit or strategic energy purpose."

Governor Patrick announced that Massachusetts will auction 100 percent of its allowances, and use the funds generated by those sales - an estimated $25 million to $125 million per year, depending on the market price of the allowances - to fund energy efficiency, demand reduction, renewable energy programs, and combined heat and power (CHP) projects, which use what is normally wasted heat from power generation for efficient heating or industrial applications. To maximize rate reduction, funds will be utilized for an aggressive program to manage peak demand for electricity, lowering electric bills for consumers across the board. Customers will have incentives to use technologies like automatic lighting and air conditioning controls that can help minimize peak-time usage. With programs like these, the ratepayer saves individually and the entire electricity system is less strained, so prices can be reduced system-wide. The result is a cheaper, more reliable electricity market.

In addition to signing the RGGI agreement, Governor Patrick announced another clean-energy initiative:

- **Purchasing renewable electricity for state agencies.** The state Division of Energy Resources (DOER) will issue a request for proposals to arrange for the procurement of renewable electricity, using $17 million to cover the price differential between renewable and traditional energy. This program will leverage over $50 million in power purchases and will meet a substantial portion of the electricity needs of five state agencies, representing approximately 15 percent of the electricity used by the Executive Branch (or five percent of all public agencies), over the next 12 years. The five state agencies are the Departments of Environmental Protection, Conservation and Recreation, and Fish and Game, along with MassHighway and the Registry of Motor Vehicles. The procurement plan will spur the development of renewable power plants in Massachusetts that utilize biomass, wind, and other renewable fuels.

"Massachusetts should become a global center for clean energy," said Governor Patrick. "Making Massachusetts a customer for clean energy products is just the beginning."

Finally, Governor Patrick also announced that Massachusetts would reengage with the Conference of New England Governors and Eastern Canadian Premiers, a cross-border regional organization of state

and provincial leaders. As a first step, Governor Patrick directed Secretary Bowles to attend the Conference's Ministerial Forum on Energy and Environment in Quebec City in February.

GOVERNOR PATRICK ANNOUNCES NEW MANUFACTURING PLANT FOR EVERGREEN SOLAR, PLAN TO BOOST CLEAN ENERGY, JOBS

Incentive and financing package, state policy commitments, and path-breaking alliance with utility make Massachusetts ripe for growth

BOSTON - Tuesday, April 17, 2007 - Governor Deval Patrick today announced that, with state assistance, Marlborough-based Evergreen Solar Inc. will build a manufacturing plant located in Westborough. This expansion will result in 350 to 375 new jobs - more than doubling Evergreen Solar's current Massachusetts employment.

"I've said all along, if Massachusetts can get clean energy technology right, the world will be our customer," said Governor Patrick. "Evergreen Solar is one of the companies that's going to help us get clean energy right. I am proud that my economic development and energy and environmental affairs teams were able to help Evergreen Solar grow and thrive right here in Massachusetts, and give us a head start toward building a clean energy economy."

Also key to the development of solar power as a clean energy source and an industry in Massachusetts is a first-in-the-nation partnership between a manufacturer of solar photovoltaic products and an electricity distribution utility announced today. Evergreen Solar and NSTAR have announced an alliance that will combine Evergreen Solar's photovoltaic technology with NSTAR's expertise, capabilities, and customer relationships for a new model of solar market development. Utilities National GRID and Western Massachusetts Electric have also entered into discussions about forming similar relationships with Evergreen Solar.

"We are most appreciative of Governor Patrick's efforts in creating the conditions that made sense for us to expand in the place where we got our start," said Richard Feldt, president and chief executive officer of Evergreen Solar. "Governor Patrick's vision for broad scale solar adoption through an innovative solar incentive program as well as the creative financial incentive programs the state had to offer influenced our decision to expand in Massachusetts. Finally, the Governor's efforts to encourage utilities to use their substantial infrastructure to improve solar market delivery should help us close the gap between solar and conventional energy costs."

"This program with Evergreen Solar will expand renewable energy choices for our customers by making solar installations more accessible and affordable," said Thomas J. May, NSTAR Chairman, President and CEO. "Customer interest in clean energy options is growing, and we are committed to offering them an increasing number of options to choose from."

Today's announcement at Evergreen Solar's Marlborough Science and Technology Center highlighted three key developments:

- Evergreen Solar's $150 million manufacturing plant, to be built in Westborough, adjacent to the campus of the Massachusetts Technology Collaborative (MTC). A $44 million financing package put together by the Massachusetts Office of Business Development includes $23 million in grants to the company and its host community, $17.5 million in low-interest loans from public and private entities, and $3 million in savings from a low-cost 30-year lease of state-owned land.

- A first-in-the-nation alliance between a solar manufacturer and an electric utility, with NSTAR agreeing to help Evergreen Solar identify prospective solar customers and to provide its customers with information on solar power, along with referrals to reputable installers and potential sources of financing.

- A commitment by the Commonwealth to aggressive goals for installed solar power generating capacity - from roughly 2 MW today to 250 MW by the end of 2017 - by strategic use of renewable energy funds and new regulatory incentives for solar power adoption by residential, commercial, and industrial customers.

  "Today marks a major step on the road to our clean energy future," said Governor Patrick. "I am proud to share this day, and this road, with my friends at Evergreen Solar and NSTAR."

GOVERNOR PATRICK LAUDS EXPANSION OF RENEWABLE ENERGY INDUSTRY AND STATE USE OF SOLAR AND WIND ENERGY

BOSTON- Monday, April 7, 2008 - Governor Deval Patrick today made two announcements relative to renewable energy in Massachusetts - a second phase of expansion by Marlboro-based Evergreen Solar at its manufacturing facility in Devens, and a year's worth of progress with state agencies adopting renewable energy under the Governor's "Leading By Example" Executive Order.
At a ceremony held at the Massachusetts Water Resources Authority's Deer Island wastewater treatment facility, Governor Patrick congratulated MWRA for its leadership on renewable energy, as demonstrated by the just-completed installation of a 100-kW array of solar panels - made by Evergreen Solar - and by its plans, announced for the first time today, to erect two 190-foot wind turbines at Deer Island as well.

"MWRA has been superlative in its efforts to use clean, renewable energy in its operations," said Governor Patrick. "With solar panels today, and wind turbines tomorrow - for all to see, as people fly in and out of Logan Airport - MWRA is truly leading by example as we create a clean energy economy for Massachusetts."

Evergreen Solar CEO Richard Feldt joined Governor Patrick at the event, and announced that his company will double the size of the manufacturing plant it has under construction in Devens, adding another 350 jobs. Evergreen chose Massachusetts for its first full-scale U.S. manufacturing facility over several other competing locations last year, due in part to a $44 million state financing package and Governor Patrick's pledge to increase the amount of solar power installed statewide from 4 MW at that time to 250 MW by 2017.

As part of that commitment, the state launched Commonwealth Solar, a rebate program launched in January to help lower the cost of purchasing and installing solar electric power. The first Commonwealth Solar-supported installation was completed just one month later, and 43 applications have been accepted to date, for a total of 260 kW of solar capacity. Backed by $68 million in existing renewable energy funds, the goal of Commonwealth Solar is installation of 27 MW of generating capacity over four years.

"With this expansion, we will have approximately 1,000 employees in Massachusetts in 2009 - triple our employee base today - and we will be one of the leading 'green' employers in the Commonwealth," said Feldt. "The vision for broad scale solar adoption, through Governor Patrick's innovative Commonwealth Solar incentive program plan for clean energy jobs as well as the financial incentive package that the Governor the Legislature provided Evergreen, were key to our decision to put our first major manufacturing facility in Massachusetts."

"Evergreen Solar is at the leading edge of our clean energy economy in Massachusetts," said Governor Patrick. "The expansion announced today demonstrates what we can accomplish when the Commonwealth works with industry leaders to create markets, jobs, and opportunities in clean energy technology, for the benefit of our economy and our environment."

"Massachusetts is making tremendous progress on solar, building both solar projects and solar jobs," said Paul Gromer, executive director of the Solar Energy Business Association of New England. "By putting solar on state buildings, the Commonwealth is setting an example for every building owner in Massachusetts to follow. And, with the recently announced Commonwealth Solar program, the state is providing the resources we need to follow that example. Thanks to Governor Patrick's support, solar is providing clean energy and green jobs for Massachusetts."

The Deer Island solar and wind projects come in response to Governor Patrick's Executive Order 484, "Leading By Example - Clean Energy and Efficient Buildings," issued April 18, 2007. That Executive Order sets ambitious standards for reduction of energy use and greenhouse gas emissions by state agencies, as well as increased use of renewable power - 15 percent of state government energy use by 2015, 30 percent by 2020.

The solar installation at Deer Island is one of 12 solar projects under way at state and community college campuses, the Soldiers Home in Chelsea, and Department of Correction facilities - all to be completed this summer. These projects alone will total a 20-percent increase in solar capacity statewide since January.

The Federal Aviation Administration gave preliminary approval for the two wind turbines on Deer Island March 7, issuing a determination of "no hazard to air navigation," which becomes final April 16 following a public comment period. MWRA will seek similar FAA determinations to allow three more turbines at Deer Island after the construction of these two windmills by late 2009. Solar panels will save MWRA an estimated $10,500 in annual electricity purchases, while the two wind turbines will save the authority an estimated $106,000 a year.

Other wind projects are in the works at state agencies, including Cape Cod Community College, Mount Wachusett Community College, the state prison at Gardner, and the Plymouth County House of Correction. In addition, a meterological tower has been erected near the Blandford rest area on the Massachusetts Turnpike to gather data for a potential set of wind turbines at the Turnpike's highest elevation.

This activity is part of the commitment to clean and renewable energy shared by Governor Patrick, Senate President Therese Murray, and House Speaker Salvatore DiMasi. A comprehensive energy reform bill, promoting energy efficiency and renewable energy, has passed both houses of the Legislature and is now in conference committee. An Advanced Biofuels Task Force appointed by the three leaders is due to release its final report and recommendations in the coming weeks, supplementing their jointly backed biofuels bill now pending in the Legislature.

"Governor Patrick's announcements today accelerate the momentum of the clean energy cluster in the Commonwealth," said Secretary of Energy and Environmental Affairs Ian Bowles, who serves as chairman of the Massachusetts Water Resources Authority board of directors. "This is a shared priority for Governor Patrick, Speaker DiMasi, and Senate President Murray and the pending energy legislation will further build that momentum. That legislation will not only cut energy costs, but also make dramatic reforms to the energy market that clear the path for robust growth in both renewable energy installations and clean energy jobs in Massachusetts."

05.01.08 - Comprehensive Clean Energy Strategy

Governor Deval L. Patrick

Clean Energy Strategy Remarks to Greater Boston Chamber of Commerce

May 1, 2008

As Delivered

Good morning.

What I'd like to do this morning is offer some observations on the Commonwealth's economy, some of the steps we are taking to adjust in the short run, and at least one of the areas where I believe there is potential for significant long-term growth. And then we can have some conversation which is really the fun part.

We are connected to and influenced by national economic trends, of course, and the news on the national front is worrisome. There's no doubt about that. Employment has declined nationally for four straight months, and economists forecast a fifth straight month of job losses for April. Although the financial houses on Wall Street appear - at least for the time being- to be stabilizing, the shakeout from the credit meltdown continues to affect communities nationwide.

Now Massachusetts, at least so far, is holding her own, faring better than most parts of the country. At 4.4 percent, our unemployment rate remains below the national average, where it has been for nearly a year. Though we have lost ground in retail, and in construction and manufacturing, we are gaining in education, health care and high tech. Over the last three months, the Massachusetts economy added 3600 jobs, 4600 when you add in December, the 8th highest number of jobs added in the country, while the nation was loosing jobs - over 200,000. Yesterday, a University of Massachusetts study indicated that the state's economy grew five times faster than the national economy during this same period. State revenues have continued to run ahead of benchmark through April, for every month of this fiscal year so far.

Now all of that is a distinct change from the last two U.S. recessions, when the downturns hit us earlier and harder.

But still, no single state's economy is recession proof. If things get worse nationally, we will feel it here. And let's face it, if the job just cut is yours or the sales that are tanking are yours, the

relative strength of the Massachusetts economy is cold comfort.

Foreclosures topped 2,800 in the first three months of this year - more than double the first quarter of last year. Many, many of our fellow residents - maybe some of you in this room- are anxious about their circumstances today and in the near future.

Last month, with the help of the Speaker and the Senate President, I laid out a four-part plan to address some of our current and future economic needs and opportunities. That plan involved restraining discretionary state spending; accelerating investment in our infrastructure and people; positioning ourselves for long-term growth in a couple of key areas; and securing the safety net for vulnerable people and small businesses.

Since that address, I have implemented spending controls that will generate nearly $200 million in savings. I've signed a $3.5 billion transportation bond bill. I've developed with the Legislative Leadership and the Treasurer a means to finance the repair of hundreds of structurally deficient bridges. I've released $1.4 million dollars in Workforce Training grants to train nearly two thousand workers in hospitals, banks, clean tech and manufacturing; and announced 4 of the 16 growth districts so called -- the ones in Chicopee, Haverhill, Weymouth and Worcester -- that will serve as regional economic engines and hubs for development planning.

As of today, homeowners are entitled to a 90-day "right-to-cure" mortgage delinquencies. The 90-day period acts as a mandate for lenders to try to restructure loans, a result that not only preserves homeownership for residents and avoids the destabilizing effect foreclosures have on entire neighborhoods, but also produces a continuing revenue stream for lenders.

We are implementing other measures - many of which were announced yesterday with the Attorney General - to help homeowners and communities struggling with foreclosures, and we are working with Congressman Frank and the others members of the congressional delegation on a more sweeping national response to the foreclosure issues.

Now there is more that we can and must do; but we are making progress.

The Life Sciences Package as Paul mentioned the Energy Packages have passed out of the House and Senate and will be on my desk soon. The Legislative Leaders have pledged both publicly and privately to enact the several pending bond bills before the end of the session. That will enable some $16 billion of investment in our roads and bridges, in our public and affordable housing, in public colleges and universities, broadband expansion, beaches, parks and other recreational facilities.

Investing in our infrastructure and ourselves creates the foundation for the state's economic growth over the coming decade, and creates good jobs right now.

But I want to focus today on one permanent fact about our economic future. I am talking about energy. Here in Massachusetts I believe this presents both a challenge and an opportunity.

Today, crude oil is trading around $115 a barrel. Gasoline as you know is at $3.50 a gallon for regular at the pump. Diesel is at $4.38 a gallon, a buck fifty higher than just a year ago. And those costs find their way into every single thing that we buy. Home heating oil recently hit $4 a gallon, just six months after it broke the $3 a gallon record. The average household in Massachusetts spent $2,500 last year to heat their home with oil, up from $1,800 the winter before. Now that average will be $3,200 next winter - if, if the price of home heating oil doesn't go any higher than it is right now.

The rise in crude oil prices hasn't made its way fully into electricity costs yet, but it will. The price of electricity in Massachusetts generally tracks natural gas prices, and that is expected to rise significantly over the course of the year. When it does, we will see it in our electric bills. It effects every family, every individual, every business in this state.

And even if the volatility of oil and gas sources becomes less of a factor over time, demand is likely to continue to rise. The entry of China and India into the global economy as consumers is unlike any phenomenon in economic history. With no oil, coal or natural gas supplies of our own here in Massachusetts, we have always been at the end of the pipeline and at an economic disadvantage. High prices for fuel oils, for fossil fuels are likely to be with us for a very long time indeed.

Add to that the threat of global climate change and Massachusetts is very much at risk. In fact, it's affecting us in some respects already. With hundreds of miles of coastline threatened by sea level rise, many property/casualty insurers are already forecasting catastrophic events as a basis for exorbitant increases in home insurance premiums.

I believe the age of fossil fuels is coming to end - and that the age of clean energy will follow.

And I really believe we must think of this as a shift in age, not merely a shift in resource. The Stone Age didn't end, as someone said, because we ran out of stone; it ended because humankind had a better idea. Clean energy is a better idea - better for our pocketbooks, better for the planet, and better for our economy, as well.

Massachusetts has what it takes to lead a clean energy economy -- because in the age of clean

power, will be power not from fossil fuels, but from technology, innovation and skill. Those are resources we have in abundance - here in Massachusetts and they are infinitely renewable.

Speaker DiMasi was among the first on Beacon Hill to recognize this and to act on it. He filed a comprehensive energy reform bill last year. Secretary Ian Bowles and I have been working hard, hand-in-hand with the Speaker, Chairman Dempsey on the House side, and Senate President Murray and Chairman Morrissey on the Senate side, to craft a piece of legislation that will put Massachusetts at the forefront of energy innovation. It comes just as the Nation, at long last, is awakening to the need for it. And this is very, very good news.

This legislation will unleash energy efficiency - the cleanest energy of all, and the ultimate defense against rising energy prices. For years, we've given electric utilities a fixed amount of ratepayer funds - $125 million a year - to spend on energy efficiency upgrades - and not a penny more, no matter how much more we could save by consuming less. The pending energy bill will require electric utilities to obtain any and all energy efficiency whatever costs less. or whenever it costs less than power generation. That means the utility will work with you in your homes, and offices and factories on lighting, appliances, insulation, and other tactics to deliver your energy needs through greater efficiency rather than simply by generating more power. And it will be done not as an add-on to your utility bill, but as an integral part of the way your utility company meets your energy needs.

It will work this way: when your electric utility - NStar, National Grid, or any other - looks at how much electricity it's going to need to buy to meet the demands of its customers, it will become required to identify all the cost-effective opportunities available to save electricity. That means replacing lighting, air conditioning, and industrial equipment with more efficient models through customer incentives that cost the utility less than it would to contract for the same amount of electricity from power plants.

Giving you the tools to take charge of your energy use will be good news for controlling costs and good news for clean energy.

The legislation will also require utilities to enter into long-term contracts for renewable energy. That means that renewable power developers will have a more stable basis on which to get financing for their projects. The bill's "net metering" provisions will make it easier for people who own smaller scale solar, wind or distributed power to sell their extra power back into the grid at a favorable rate. And it will integrate our state building code with the standards of the International Energy Conservation Code, keeping Massachusetts at the forefront of energy efficiency in new buildings.

Energy efficiency is real thing this is not some abstract concept. I want to tell you why; give you an example. Crane & Co., a venerable company in Western Massachusetts, has been making fine paper products, including the specialized paper used for currency, for more than 200 years. On a visit to their Dalton facilities, I learned they were groaning under the weight of their energy costs. Phil Giudice, our Commissioner of the Division of Energy Resources - is Phil here? There is Phil. You should stand up Phil because everybody's gunna' want to know you. Commissioner Giudice went out to see Crane and he lead one of our new Commonwealth Energy Resource Teams - the SWAT teams of professionals from various state agencies, all focused on solving energy challenges for industry. The Industrial Assessment Center at UMass-Amherst conducted a full energy audit. Crane Paper has decided to implement all but one of the efficiency measures recommended. Here's the punch line: that implementation will save them $600,000 a year. $600,000 a year.

We all stand to gain from energy efficiency, by learning to manage energy the same way we manage other kinds of consumption.

Under the new energy legislation, this will become easier to do. The utilities and independent energy services companies will be coming to you, looking for ways to improve your energy efficiency - at your company, or at home - saving you money, and saving all of us by reducing electricity demand overall. It's all about meeting the energy needs in the smartest, cheapest, and most environmentally sensitive way.

When efficiency competes with generation by the way on the basis of cost, efficiency generally wins. ISO New England, which operates our power grid, recently held its first auction of the Forward Capacity Market, accepting bids for ways to meet future electricity needs. Two-thirds of the awards in that auction went to demand-management resources (translation: efficiency applications); only one third to new generating resources.

Besides saving money, energy efficiency represents an economic growth opportunity. It means jobs for people who remove old light fixtures and install new ones, folks who replace old furnaces and air conditioners, and swap out old motors with new variable frequency ones - even people who go door to door, replacing incandescent light bulbs with compact fluorescents today, or light-emitting diodes tomorrow.

Energy efficiency is just one part of the clean energy economy of the future. And the energy legislation is just one of the ways that state government is leveraging Massachusetts's strengths in basic and applied research, venture capital, and technology innovation. We are already growing the clean tech sector in Massachusetts and you know about that.

Take solar power. Evergreen Solar - and I saw Rick Fedlt here earlier today. Where are you Rick? Here is Rick, the Chairman and CEO of Evergreen Solar headquarters in Marlboro, building its first full-scale U.S. manufacturing operation in Devens right now. By next year, Evergreen will have tripled its Massachusetts workforce, up to 1,000 workers in just two years.

Now Evergreen is expanding here, not just because we were able to offer a package of incentives that was competitive with several other states. What made the difference was the commitment we are making to grow the market for solar photovoltaic energy

To that end, in January, we launched Commonwealth Solar, a rebate program that uses existing renewable energy funds to defray the cost of solar installations. The program offers rebates of up to 60 percent of the cost for homeowners, and up to 40 percent for businesses - up to $1 million for a large commercial installation. In just three months of operation, Commonwealth Solar has approved nearly 60 applications, for rebates totaling more than $1 million and 350 kilowatts in generating capacity.

Clean energy technology creates jobs, too, and not just in the lab. One of the biggest boosters of solar and wind energy in Massachusetts is Marty Aikens of IBEW Local 103 - the proud owners of the wind mill and rooftop solar panels you see as you drive - where are you Marty are you here? Marty stand up. (applause) - you down the Southeast Expressway and you see the windmill and the solar instillation on their roof that is Marty's doing. Where environmentalists see carbon-free energy, Marty sees jobs for electricians installing solar panels and assembling wind turbines and the beauty of that is they're both right.

The point is: green-collar jobs come in shades of both blue and white. Over the last few years, our state colleges, community colleges and 40 Vocational Technical High Schools have begun to develop clean energy technology training programs. YouthBuild is including green building techniques in their training of at-risk youth in construction trades. The clean energy sector in Massachusetts employs more than 14,000 people right now today, and is growing fast. Graduates of these programs will be in high demand.

Now Dan Leary needs that talent. Where's Dan? You here Dan? There's Dan Leary. I'm gunna tell you about Dan Leary. Dan was a student at the Isenberg School of Management at UMass-Amherst when he was called to serve his country in the Army. While leading a unit in Kuwait, Captain Leary worked on his master's thesis in his spare time. That thesis was a business plan for a solar power delivery company.

He finished his tour of duty, finished his thesis, and - with the help of a grant from the Renewable Energy Trust - he started a company called Nexamp. At first Nexamp was Dan, his laptop and his

pickup truck. But in two years, Nexamp has become a 12-person operation, most of them fellow veterans - if I understand it correctly - and located in North Andover. Dan is looking to add 5 more jobs by the end of the summer. And good for you Dan. Keep it up. (Applause) Did you bring business cards today by the way? That's the way. Solar power is just one of the clean energy technologies where Massachusetts can use our expertise to solve our own energy problems -- and then show the world how to solve theirs as well.

Wind power is another. Wind is the fastest-growing power generation source on the planet right now. For a time, thanks to the vigor of opposition to Cape Wind, Massachusetts was regarded as hostel to wind power. In fact, there are thoughtful concerns raised in opposition to that project; but I believe on balance Cape Wind is good for Massachusetts, both practically and symbolically. The project has received state environmental approval and is moving toward a final decision from federal authorities. Before too long, I believe, the first offshore wind farm in America will be located just off the coast of Massachusetts, a powerful statement of our commitment to a clean energy future.

There are other promising developments in wind technology that you should know about as well. Last year, we were chosen, we in Massachusetts were chosen by the federal Department of Energy as the location for one of just two Wind Technology Testing Centers in the country. That means we'll be soon testing wind blades in Charlestown for projects everywhere. Hull has two turbines generating its municipal electricity needs today. And the MWRA will erect two wind mills soon to help meet its needs -- at the same time symbolizing for every traveler landing at Logan that we aim to become the world's hub for clean energy innovation.

The Oceans bill, which the Senate President has championed, is a further component of our energy strategy. This legislation will make Massachusetts the first state in the nation to have a comprehensive management plan for our state waters, including identification of sites appropriate for renewable energy development. That means balanced, thoughtful planning that allows for development of offshore wind, wave and tidal power generation - leadership not just among states, but a model for federal waters as well.

Biofuels represents another opportunity for Massachusetts. Now you may have read concerns about bio around the country and the world about the unintended consequences of biofuels made from corn and from soy, particularly their impact on food prices and the energy used and emissions generated by making the stuff. Well, Massachusetts researchers and companies are at the forefront of the next generation of biofuels, which come from the cellulose that's found in non-food sources like wood, agricultural wastes, and switchgrass. Indeed, researchers at UMass Amherst have discovered what they call the QMicrobe, bacteria that convert cellulose to ethanol

in a single step - a transformational breakthrough.

We need to encourage the commercialization of these breakthroughs. So, the Speaker, the Senate President and I are working on a bill to exempt cellulosic biofuel from the state's gasoline tax. That measure will provide stimulus for Massachusetts companies like Mascoma and SunEthanol - SunEthanol is the company that's based on that UMass-Amherst research I mentioned - to bring their products to market.

Long-term support for advanced fuel and vehicle technologies will come from the Low Carbon Fuel Standard the Senate President, Speaker and I have agreed to develop as well. We would be the first state after California to create such a standard. But frankly, given our relative geographic size and our footprint, this policy would be much, much more effective on a regional basis, where it can match our regional distribution system and take advantage of economies of scale.

So, I am reaching out to the Northeast states who, like the Commonwealth, are members of the Regional Greenhouse Gas Initiative, to ask them to work with us on this mechanism for. Indeed, I believe that New England Governors can develop a common agenda to reduce emissions from vehicle fuels and in the process make New England the most energy-efficient region in the country. And we've even launched a New England Clean Energy Council to foster collaboration within the sector.

So the idea is a simple one: if Massachusetts gets clean energy right, the whole world will be our customer. And today, I can tell you, we are well on our way, thanks to the incredible technological and entrepreneurial talent we have already here in our great Commonwealth, and thanks to a set of policy leaders in state government who share this vision, and are willing to work shoulder to shoulder to pursue it. Like I said, the age of fossil fuels is passing. If we act now, the age of clean energy is ours.

Thanks for having me I appreciate it.

Governor Patrick Signs Law Creating First-in-the-Nation Oceans Management Plan Balancing Preservation, Uses

BOSTON- Wednesday, May 28, 2008- Governor Deval Patrick, with the support of House Speaker Salvatore F. DiMasi and Senate President Therese Murray, today signed the Oceans Act of 2008, legislation that will require Massachusetts to develop a first-in-the-nation comprehensive plan to manage development in its state waters, balancing natural resource preservation with traditional and new uses, including renewable energy.

"This legislation will make Massachusetts the first state in the nation to create a comprehensive plan for the management of its ocean waters," said Governor Patrick. "This law will help protect our vital natural resources and balance traditional with new ones, such as renewable energy, that are also important to our future."

Governor Patrick signed the bill at the New England Aquarium.

"This is significant, one-of-a-kind legislation that sets specific guidelines for development projects in our state waters and provides safeguards for the health and preservation of our ocean," Senate President Murray (D-Plymouth) said. "We have well-established laws for the use of our land, and now we will have the necessary framework and process in place for the management of one of the Commonwealth's greatest assets - our ocean. I congratulate Senator Robert O'Leary and the rest of the Senate for initiating this proposal and seeing it through the Legislative process, and I also thank the House of Representatives and the Governor for seeing the merits of this legislation. The Commonwealth will be a better place because of it."

"This legislation will help more effectively manage our most abundant and precious natural resource: our ocean waters," said Speaker DiMasi. "Through this law, Massachusetts will create a framework to balance the competing interests in our oceans, putting in place regulations to govern oceans and creating a new avenue for viable renewable energy production in our Commonwealth. I commend Senate President Murray, Governor Patrick, and Secretary Bowles on their dedication to and collaboration on this legislation."

In 2003, the Pew Commission on Oceans and the US Commission on Ocean Policy issued reports calling for significant reform of state and federal policy on management of ocean waters off the US coast. At the same time, Massachusetts launched an Ocean Management Task Force that similarly targeted state regulation as inadequate to the challenge of balancing competing uses of state waters and resource

preservation.

"With this bill, Massachusetts has become a leader in ocean policy in this country," said Leon Panetta, former White House Chief of Staff, chair of the Pew Oceans Commission, and co-chair of the Joint Ocean Commission Initiative. "The political leaders in the state really deserve strong recognition for taking the initiative and passing this unprecedented ocean management legislation."

The Oceans Act requires the Secretary of Energy and Environmental Affairs to develop a comprehensive ocean management plan, following a scientific and stakeholder process leading to a draft plan by summer of 2009. The legislation sets a deadline of December 31, 2009, for final promulgation of the ocean plan.

Upon final adoption, the ocean plan will be incorporated into the existing coastal zone management plan and enforced through the state's regulatory and permitting processes, including the Massachusetts Environmental Policy Act (MEPA) and Chapter 91, the state's waterways law.

The new law stipulates:

Comprehensive Management of Natural Resources: This bill requires, for the first time in any state, comprehensive science-based planning of the Commonwealth's ocean waters to assure long-term protection and sustainable use of a resource that has been the historical bedrock of Massachusetts industry and culture.

Ocean Advisory Commission:The bill creates a 17-member ocean advisory commission to provide advice to the Secretary as the Executive Office of Energy and Environmental Affairs develops the plan. The commission is comprised of 17 members, including state representatives, state senators, 3 agency heads, 1 representative of a commercial fishing organization; 1 representative of an environmental organization; 1 representative who has expertise in the development of offshore renewable energy; and 1 representative each from the Cape Cod Commission, the Martha's Vineyard Commission, the Merrimack Valley Planning Commission, the Metropolitan Area Planning Council, and the Southeast Regional Planning and Economic Development District. The Governor appoints the eight nongovernmental seats.

Ocean Science Advisory Council:The Secretary will also receive assistance from an ocean science advisory council, comprised of nine scientists who have expertise in marine sciences and data management.

DMF Jurisdiction: The jurisdiction of the division of marine fisheries is not altered by the ocean plan - the legislation is explicit in stating that the oceans plan is not intended to alter fisheries policy.

Appropriately Scaled Renewables: The bill amends section 15 of the Ocean Sanctuaries Act to allow

for the siting of "appropriate scale" offshore renewable energy facilities in state waters except for the Cape Cod Ocean Sanctuary (offshore from the Cape Cod National Seashore on the Outer Cape) provided that the facility is consistent with the ocean plan.

The Oceans Bill has been pending in the Legislature since 2004, this year winning approval from the Senate, the House, and the Patrick Administration to become law. The Senate passed a version of the bill in September, and the House approved its version in February. A consensus draft of the bill was enacted by the Senate May 15 and the House May 22.

"The Oceans Act gives Massachusetts an unprecedented opportunity to manage its offshore assets to maximum effect, preserving its irreplaceable resources and making optimal use of those that are renewable," said Secretary Ian Bowles. "When we make best use of our state waters, we will all be better off."

Governor Patrick Signs Energy Bill Promoting Cost Savings, Renewable and Clean Energy Technology

Legislation will hold down electric bills, promote the development of renewable energy, and stimulate the clean energy industry

BOSTON - Wednesday, July 2, 2008 - Governor Deval Patrick today signed the Green Communities Act, a comprehensive energy reform bill resulting from close collaboration with House Speaker Salvatore DiMasi, who filed the bill in 2007, and Senate President Therese Murray, who led the Senate to pass its version in January.
"Today, Massachusetts has taken a giant step forward toward a clean energy future," said Governor Deval Patrick, who signed the bill at a ceremony at the Museum of Science. "This legislation will reduce electric bills, promote the development of renewable energy, and stimulate the clean energy industry that is taking root here in the Commonwealth."

"This new law puts Massachusetts in the lead nationally in crafting bold, comprehensive energy reform," said House Speaker Salvatore F. DiMasi. "This law will spark a significant increase in the use of renewable energy that will significantly curtail our use of fossil fuels, improve our environment and save us all money in the long run. Working together, we in the House, Senate and Patrick administration have much to be proud of."

"With the cost of energy skyrocketing, this legislation comes at a critical time and puts Massachusetts at the forefront of clean energy policies and the development of alternative fuel sources," Senate President Therese Murray said. "With this landmark legislation, the Commonwealth will tip the scales away from fossil fuels in favor of more efficient and affordable energy alternatives. Emerging technologies and conservation are major parts of this effort, and Massachusetts will lead the way."

Lower Energy Costs
Under the new law, the state will make energy efficiency programs compete in the market with traditional energy supply. Utility companies (NSTAR, National Grid, Western Mass. Electric, etc.) will be required to purchase all available energy efficiency improvements that cost less than it does to generate power, ultimately saving money on consumers' electricity bills.

Utility companies will offer rebates and other incentives for customers to upgrade lighting, air conditioning, and industrial equipment to more efficient models, whenever those incentives cost less than generating the electricity it would take to power their older, less-efficient equipment.

Existing efficiency programs have already shown savings at 3 cents per kilowatt-hour versus 9 cents for power generation. Customers who take advantage of these incentives will save money as they reduce

how much energy they use. The incentives will encourage more efficient energy use, lowering the overall demand on the system and reducing greenhouse gas emissions.

Promoting Renewable Energy
The Green Communities Act promotes renewable energy in a number of ways. The law requires utility companies to enter into 10- to 15-year contracts with renewable energy developers to help developers of clean energy technology obtain financing to build their projects. The agreements will target Massachusetts-based projects.

The law also makes it possible for people who own wind turbines and solar-generated power to sell their excess electricity into the grid ("net-metering") at favorable rates, for installations of up to 2 megawatts (up from 60 kilowatts currently).

The measure also authorizes utility companies to own solar electric installations they put on their customers' roofs - a practice that was previously prohibited - up to 50 MW apiece after two years. If utilities take full advantage of this new opportunity, it will poise Massachusetts to meet Governor Patrick's goal to harness 250 megawatts of installed solar power by 2017.

Making State and Municipal Power Greener
A new Green Communities program comes into effect under the new law, offering benefits to municipalities that make a commitment to efficiency and renewable energy. The state Division of Energy Resources, which is expanded and elevated into the Department of Energy Resources, will now include a Green Communities Division to provide technical and financial assistance to municipalities for energy efficiency and renewable energy efforts. The program will receive $10 million in funding from a variety of sources, including emissions allowance trading programs, utility efficiency charges, alternative compliance payments generated by the Renewable Portfolio Standard, and the Renewable Energy Trust Fund.

In addition to these provisions, the new energy law doubles the rate of increase in the Renewable Portfolio Standard from 0.5 percent per year to 1 percent per year, with no cap. As a result, utilities and other electricity suppliers will be required to obtain renewable power equal to 4 percent of sales in 2009 - rising to 15 percent in 2020 and 25 percent in 2030, and more thereafter. In addition, the Massachusetts Renewable Energy Trust Fund, which is administered by the Massachusetts Technology Collaborative, comes under the direction of a new governing board chaired by the Commissioner of the Department of Energy Resources.

The law also requires the State Board of Building Regulations and Standards to adopt, as its minimum standard, the latest edition of the International Energy Conservation Code as part of the State Building Code. This will keep Massachusetts building standards at the highest international levels of energy efficiency.

The Green Communities Act gives final legislative approval to the Commonwealth's participation in the Regional Greenhouse Gas Initiative (RGGI). Substantially all of the emissions allowances issued under the program will be auctioned - in accordance with the policy announced by Governor Patrick in January 2007 - allowing the proceeds to go toward reimbursing municipalities that lose property tax receipts as a

result of RGGI mandates, funding Green Communities, providing no-interest loans for municipal energy efficiency projects, and promoting energy conservation.

"With this legislation, Massachusetts takes its rightful place as a national leader in energy reform and environmental protection," said Secretary of Energy and Environmental Affairs Ian Bowles. "This legislation will help businesses and residential consumers fight rising energy costs, reap the benefits of renewable energy, and grow our clean energy industry."

07.02.08 - Energy Bill Signing

Governor Deval L. Patrick

Energy Bill Signing

July 2, 2008

As Delivered

Speaker DiMasi, Senate President Murray, General Coakley, Congressman Delahunt, Secretary Bowles, our partners in state and local government, in all the quasis. Ladies and gentleman, boys and girls, I am here today to sign into law the best clean energy bill in America. [applause]
The Green Communities Act is a giant step forward toward a clean energy future and a safer environment for Massachusetts, for the United States, and for the whole world. It does so by unlocking the power of efficiency of renewable energy, and of clean energy technology. Massachusetts, as many of you here know, has been among the nation's leaders in promoting energy efficiency for a long time now. But we have artificially capped our investment in efficiency, even though efficiency investments generally are a third as much, a third cheaper, than what it takes to create traditional electricity supply. From now on, conventional generation will have to compete with efficiency for our energy dollars.

In a number of ways, the act also promotes development of renewable power sources; it authorizes long term contracts for renewable energy producers, which stabilizes the markets and enables renewable energy entrepreneurs to raise the capitol they need to expand the industry; it allows utilities to install solar panels in individual's homes, relieving homeowners of that costly upfront investment and expanding adoption of solar alternatives; and it gives residential and commercial owners maximum benefit from the solar and wind power that they install themselves by allowing them to sell excess energy back into the electric grid at a very good rate.

Fostering new energy sources and efficiency strategies means new technologies, new investments, new companies, and new jobs. Jobs in research, in high-tech engineering, as well as in manufacturing clean energy components, and installing and repairing new technologies. We are already working closely with our community colleges to create workforce training programs to meet those training needs.

And finally, this legislation affirms our participation in the regional greenhouse gas initiative, part of a strategy to sharply reduce greenhouse gas emissions, protect us from harmful health affects, and environmental degradation and better steward the natural world for generations to come.

In September, this Commonwealth will lead the nation's first auction of greenhouse gas emissions allowances. Climate change is the challenge of our time and with this legislation, we in Massachusetts are rising to meet that challenge.

I don't think anyone here has to be reminded that this legislation could not come at a more opportune time. Crude oil is over $140 a barrel, more than twice the price of what it was just a year ago. Everyone, -- everyone -- is feeling that price at the pump and in our heating, cooling, and electricity bills. The Green Communities Act is the most sweeping overhaul of the way we make, buy, and use energy in more than a decade and it is right on time.

We have a lot of people to thank, none more so, and I say this with due respect to all of my other partners in government, but none more so than the Speaker of the House, Sal DiMasi. Speaker DiMasi was among the very first on Beacon Hill to recognize both our energy challenges and our energy opportunities. This bill reflects his vision and we would not be where we are without the leadership that he has shown from the start, and Sal I thank you for that.

I also want to commend and thank Senate President Murray who not only came to our side on this initiative but also broadened the agenda by pushing the Oceans Bill, which we signed just a few weeks ago. She recognized the comprehensive environmental stewardship meant addressing the power generation opportunities offshore as well as on land. The Oceans Bill is a part of a bigger energy and environmental picture that her vision and leadership made complete, and I thank you Senator Murray.
And in her constantly, consistently thoughtful way she reminds me not to forget it was Senator Bob O'Leary who has given us such leadership. [applause] Chairman Morrisey and Chairman Dempsey and their respective staff have been keen, diligent, imaginative, and totally engaged partners in every step of this work. It has been an absolute pleasure for all of us to work with them and I thank them and all the members of the legislature for delivering a really fine result. [applause]

And Secretary Bowles and his team have done an absolutely outstanding job. [applause] They have gotten it consistently right on both the substance and the process and I'm just so proud that you're on the team. Thank you.
Efficiency alternatives and foresight, these are the watchwords of our clean energy future. These will be the cornerstones for the next generation of technology innovation here and all around the world. Thanks to you, all of us here on this stage, all of you who have taken a part in this, Massachusetts will be out front. And that's exactly where we ought to be. I'm proud to be with you all, thank you.

Governor Patrick Signs Bills To Reduce Emissions And Boost Green Jobs

Global Warming Solutions Act and Green Jobs Act set nation-leading limits on greenhouse gases, spur growth of clean energy industry

BOSTON - Wednesday, August 13, 2008 - Governor Deval Patrick has signed two important bills further positioning Massachusetts as a leader in clean energy and environmental stewardship: the Green Jobs Act, which will support development of the clean energy technology industry that will move Massachusetts toward the green economy of the future, and the Global Warming Solutions Act, which will make Massachusetts a national leader in climate protection.
"This legislation builds on the energy, oceans, and biofuels bills passed this session - all positioning Massachusetts as the clear national leader in creating a clean energy economy," said Governor Patrick. "Massachusetts will lead the way in reducing the emissions that threaten the planet with climate change, and at the same time stimulate development of the technologies and the companies that will move us into the clean energy age of the future."

The Green Jobs Act will provide support for the growth of a clean energy technology industry, helping Massachusetts to meet goals for reducing greenhouse gas emissions. Backed by $68 million in funding over five years ($43 million from the FY07 surplus and $5 million per year from the Massachusetts Renewable Energy Trust), this legislation gives initial authorization for $5 million in RET funding next year as well as $1 million each in for seed grants to companies, universities, and nonprofits; workforce development grants to state higher ed, vocational schools, and nonprofits; and low-income job training (Pathways Out of Poverty); plus $100,000 for a study of the clean energy sector.

"Massachusetts is leading the way in comprehensive energy reform and all of this session's accomplishments - from Green Communities and advanced biofuels standards to global warming solutions and now green jobs incentives - make us the envy of the nation," said House Speaker Salvatore DiMasi, who sponsored the bill. "This law will help us create good-paying jobs in an already-thriving clean energy industry that can double or triple in size in the coming years because of our hard work."

"These initiatives show that Massachusetts is serious about the future of our environment and our economy," said Senate President Therese Murray. "Promoting our emerging clean-energy sector will create jobs and boost an industry that will work to reach the goals of the Global Warming Solutions Act. By focusing on these green-collar jobs, as well as the reduction of greenhouse gases and carbon dioxide emissions, we will help to ensure a healthier future for Massachusetts."

The Global Warming law requires the reduction of greenhouse gas emissions by 80 percent from 1990 levels by 2050, with a reduction of up to 25 percent by 2020. Gradual reduction of emissions levels will spur innovation and entrepreneurship in clean energy technologies across the economy. To facilitate the innovation and economic development necessary to meet those mandates, the Green Jobs Act will

support research-and-development, entrepreneurship, and workforce development in the clean-energy technology industry of the future.

"With passage of the most progressive global warming bill in the nation, Massachusetts has positioned itself as a leader in the clean and renewable energy sector, and secured its position in the emerging green economy," said Senator Marc Pacheco, chairman of the Senate Committee on Global Warming and Climate Change. "The Legislature's approval of the Global Warming Solutions Act was an historic moment that will revolutionize the Commonwealth's future economy by spurring job growth, sparking innovation, and protecting our environment for future generations. I'm extremely pleased that we were able to take swift action now. The cost of inaction was just too great."

The law will establish a statewide and regional registry of greenhouse gas emissions. The Department of Environmental Protection (MassDEP) will determine the baseline emissions level of 1990 and calculate the expected 2020 emissions levels if no new controls were imposed after January 1, 2009 (the "business as usual" level). The Secretary of Energy and Environmental Affairs will set a 2020 emissions limit between 10 percent and 25 percent below 1990 levels and adopt a plan for meeting that limit by January 1, 2011. The Secretary will also set 2030 and 2040 limits, leading up to the required 80 percent reduction by 2050.

These bills follow three other major pieces of legislation signed by Governor Patrick to move Massachusetts toward a clean energy future:

- **The Green Communities Act** remakes the electricity marketplace in Massachusetts to favor efficiency over additional power generation, saving energy and money for consumers, and to support the development and use of renewable energy by residents, businesses, and municipalities.
- **The Oceans Act**, which requires the development of a first-in-the-nation comprehensive management plan for Massachusetts's state waters, allows for the development of wind, wave, and tidal power as part of a plan that balances new and traditional uses with preservation of natural resources.
- **The Clean Energy Biofuels Act** gives preferential tax treatment to non-corn-based alternatives to ethanol, requires biofuel content in all the diesel and home heating fuel sold in the state, and proposes a new fuel standard for the region that will encourage a range of emissions-reducing technologies for cars and trucks.

"I congratulate Governor Patrick, Senate President Murray, and Speaker DiMasi on launching the most comprehensive and forward-thinking set of clean-energy policies in the nation," said Hemant Taneja, co-chairman of the New England Clean Energy Council. "The legislation passed this year not only serves as an example to the nation that the United States must take a leadership position in addressing climate change, it will also serve to spur the early development of a low-carbon energy technology industry in Massachusetts, setting it on a path to becoming a global leader in this rapidly growing multibillion-dollar industry."

GOVERNOR PATRICK SETS NEW GOALS FOR WIND POWER

Developing wind turbines to power 800,000 homes by 2020 will boost Massachusetts as clean energy leader

BOSTON- Tuesday, January 13, 2009 - Governor Deval Patrick today set a goal of developing 2,000 megawatts of wind power capacity - enough to power 800,000 Massachusetts homes - by 2020. Citing new mandates that require greater use of renewable energy and sharp reductions in greenhouse gas emissions, Massachusetts can only fulfill these obligations with a significant commitment to wind power.

"We have already made a commitment to reaching 250 megawatts of solar power in Massachusetts by 2017, and we are moving toward that goal. Now is the time to turn to wind power, where we should reach even higher," said Governor Patrick. "With the growing interest in wind turbines we see in communities across the Commonwealth and the abundant wind resource we have off our coast, wind power is going to be a centerpiece of the clean energy economy we are creating for Massachusetts."

Massachusettshas been selected by the U.S. Department of Energy for one of just two Wind Technology Testing Centers in the country, poising the Commonwealth to become a national center for wind power research and development, offering the economic rewards of technology development, entrepreneurship, and jobs.

In April 2007, Governor Patrick established a goal for installed solar power of 250 MW by 2017, up from 4 MW installed at the time he took office. That goal was set in part as a pledge to Evergreen Solar, which was then announcing its first US manufacturing facility now built and opened in Devens, to stimulate the market for solar panels in Massachusetts. In January 2008, Governor Patrick launched Commonwealth Solar, a program financed by existing renewable energy funds, which has since provided rebates for more than 400 installations representing 4.6 MW of solar power - nearly doubling the amount of installed solar power in a year - with another 300 projects for 3.5 MW applied for but not yet awarded as of December 31. The number of solar-power installation companies has also tripled, from 25 to 75, since the launch of Commonwealth Solar.

Governor Patrick has directed Energy and Environmental Affairs Ian Bowles to use the 2,000 MW wind goal, as well as the mandates and incentives provided in the historic package of clean energy legislation enacted last year, to guide the state's efforts to dramatically increase the development and deployment of clean, renewable wind power in the coming years.

There are currently nine wind turbines with capacity of 100 kilowatts or greater installed in Massachusetts, for total generating capacity of 6.6 megawatts (MW). But there are more than 300 wind turbines, representing generating capacity of 800 MW, at various stages of planning and permitting.

Legislation enacted last year contained provisions requiring greater use of renewable energy and encouraging its development and adoption. The Green Communities Act, a comprehensive energy reform

bill, accelerated the increase of renewable energy required of all electricity suppliers, rising from 4 percent of sales to 15 percent by 2020, and set a goal of 20 percent of all electricity coming from renewables by that time.

To spur the development and adoption of renewable energy, the Green Communities Act required utilities to enter into long-term contracts with the developers of renewable energy projects, in order to help them obtain financing, and improved the economics of smaller renewable energy installations by allowing owners to sell their excess power into the electric grid at favorable rates.

"The Green Communities Act smoothed the way for wind turbines with new incentives, and municipalities around the Commonwealth are lining up to bring wind power to their communities," said Secretary Bowles. "We are going to do everything we can to help them, and create a vibrant wind power industry at the same time."

Recognizing that siting is frequently an obstacle to renewable energy development, the Green Communities Act created an energy facilities siting commission to review, in part, "whether current laws and regulations do not adequately facilitate the siting of renewable and alternative energy facilities" to propose changes. That commission is now meeting, and is expected to make recommendations this spring.

Under the Oceans Act, the comprehensive ocean management plan now under development and required to be completed by the end of 2009 is expected to identify locations in state waters other than the Cape Cod Ocean Sanctuary, off the coast of the national seashore, for potential development of "appropriate-scale renewable energy facilities." And a study of the potential for renewable power development on state-owned lands mandated by the Green Jobs Act is due February 1.

In addition, the climate bill enacted last year, the Global Warming Solutions Act, requires the Commonwealth to reduce emissions of greenhouse gases 80 percent by 2050, and up to 25 percent by 2020.

Installing wind capacity of 2,000 MW would meet an estimated 10 percent of the state's current electric load with clean, renewable wind power. And by displacing electricity generated by fossil fuels, use of wind turbines on this scale would reduce greenhouse gas emissions by 3.1 million tons, or roughly 12 percent of emissions from power plants today.

"First Wind applauds Governor Patrick's efforts to make wind energy a priority in Massachusetts," said Paul Gaynor, President and CEO of First Wind. "First Wind is proud to be a Massachusetts company in large part due to leadership that the Governor, Secretary Bowles, and the Legislature have shown in making the Commonwealth a nurturing environment for the development of alternative energies, notably wind power."

Governor Patrick Joins Legislative Leaders to Celebrate Launch of Green Communities Program

Initiative will help municipalities pursue clean energy projects, make best use of federal stimulus funds for savings

BOSTON- Wednesday, April 22, 2009 - GovernorDeval Patrick today joined legislative leaderson Earth Day to announce the launch of the Green Communities Program, which will help municipalities across Massachusetts cut energy bills through greater efficiency and locally generated renewable power. The Green Communities Program is a component of Governor Patrick's Massachusetts Recovery Plan, making information and technical assistance available for communities to help them prepare for and make the most of federal recovery funds targeted for energy investments.

"Coupled with federal recovery funds for energy efficiency and renewable power, the Green Communities Program will help communities across Massachusetts reduce costs, spur economic activity, and strengthen our collective commitment to a clean energy future," said Governor Patrick.

"Going 'green' is both an economically and environmentally sound path for cities and towns across the Commonwealth. By providing the tools to help cities and towns reach this goal, it is not just individual communities, but the entire Commonwealth that will benefit now and for generations to come," said Senate President Therese Murray. "In addition to improving our communities, this gives an extra boost to the new green collar job sector that is increasingly in demand across the Commonwealth."

"This initiative will help communities on the local level meet their environmental goals," said House Speaker Robert DeLeo. "I am also hopeful this program will provide our cities and towns with more tools as they seek federal recovery funds for energy efficiency programs."

Created by the Green Communities Act - the pioneering energy reform law enacted last year - the Green Communities Program at the Department of Energy Resources (DOER) will support local efforts that further ambitious clean energy goals shared by the Governor and legislative leaders. Envisioned as a way to encourage municipalities to make greener energy decisions, the Green Communities Program is mandated to offer grant and loan opportunities to municipalities in order to be designated as "green communities."

Types of assistance offered by the Green Communities Program will include helping communities qualify for state funding by adopting local by-laws and regulations that facilitate the siting and permitting of renewable energy facilities, benchmarking municipal energy use and reducing energy consumption, purchasing fuel-efficient vehicles for municipal fleets, and taking steps to reduce lifecycle energy costs for new commercial, industrial and residential buildings. The Act allows funding of $10 million per year from the proceeds of Regional Greenhouse Gas Initiative allowance auctions for the program.

Federal funding from the American Recovery and Reinvestment Act (ARRA) includes $42 million in Energy Efficiency and Conservation Block Grants to fund efficiency and renewable energy investments by municipalities. The Green Communities Program is now in the process of assigning four regional coordinators who will provide communities around the state with technical assistance on becoming Green Communities and on making choices about energy investments with federal funds.

"The Green Communities Program is poised to fulfill a vision that is shared by Governor Patrick and the Legislature: a one-stop shop for municipalities seeking to make the most of the clean energy opportunities available to them," said Energy and Environmental Affairs Secretary Ian Bowles. "This program will serve as a national model for community mobilization to accelerate the transition to a clean energy future."

"Now open for business, the Green Communities Program stands ready to help cities and towns across the Commonwealth make energy choices that save them money and create a greener energy future for all of us," said DOER Commissioner Philip Giudice. "We look forward to working with communities from Cape Cod to the Berkshires."

Clean energy investments are critical componentsof Governor Patrick's Massachusetts Recovery Plan, which combines state, federal and, where possible, private efforts to provide immediate and long-term relief and position the Commonwealth for recovery in the following ways:

- **Deliver immediate relief** by investing in the road, bridge and rail projects that put people to work today and providing safety net services that sustain people who are especially vulnerable during an economic crisis;

- **Build a better tomorrow** through education and infrastructure investments that strengthen our economic competitiveness, prepare workers for the jobs of the future and support clean energy, broadband and technology projects that cut costs while growing the economy; and

- **Reform state government** by eliminating the pension and ethics loopholes that discredit the work of government and revitalize the transportation networks that have suffered from decades of neglect and inaction.

For more information about Green Communities Program, visithttp://www.mass.gov/energy/greencommunities.

Patrick-Murray Administration Offers Tools to Help Strengthen Communities

Municipal pension relief, budget tools, Green Communities Grants presented at Massachusetts Municipal Association Meeting

BOSTON - Friday, January 22, 2010 - One day after proposing to fully fund Chapter 70 education funding next fiscal year and to hold the line on Local Aid, Governor Deval Patrick today offered cities and towns a host of new tools that will help protect essential local services, reduce pressure on local property taxes and strengthen communities' financial footing for the long-term.

Appearing at the Massachusetts Municipal Association Annual Meeting, Governor Patrick outlined proposals including municipal pension relief, a limited early retirement incentive program and a new Green Communities grant program to encourage development of energy efficiency and renewable energy projects to relieve local budgets. The new proposals are in addition to several tools the Governor and local officials have worked to secure for communities over the last several years.

"The Lieutenant Governor and I value the partnership we have built with local officials across the Commonwealth," said Governor Patrick. "This relationship has allowed us to work collaboratively to bring real change to the way local government provides for the residents of the Commonwealth. The tools we introduce today, coupled with the changes we have already made, will allow us to provide key services in communities today, while reducing local pressure on the property tax."

In his State of the Commonwealth address last night, Governor Patrick announced that he is including in his Fiscal Year 2011 budget $5.2 billion in Local Aid, including a record $4.048 billion for Chapter 70 education funding, fully funding foundation for every district. In addition, school districts that would have otherwise seen a cut as a result of the funding formula will instead be level funded. Unrestricted local government aid will be level funded at $936 million.

"During the past three years, Governor Patrick and I have traveled across the Commonwealth, listened to the challenges our cities and towns face and partnered with local officials to address these challenges and support our municipalities," said Lieutenant Governor Timothy Murray. "Even in these extremely difficult times, we have committed to continuing our support of communities across Massachusetts and look forward to working with city and town officials to develop the tools necessary to manage limited resources more efficiently and improve critical local services."

Local Pension Relief

Recent unprecedented market losses incurred by local pension funds will result in significant increases in the annual pension payments required to fully fund the systems on existing funding schedules. This presents a significant challenge at a time when local government resources are more constrained than ever.

The Governor today filed a municipal pension funding relief plan to help local pension systems address these losses in a fiscally responsible and manageable way without the significant increases in payments that would otherwise be required. The legislation allows local systems to extend their funding schedule subject to certain conditions, and requires that future asset gains be used to shorten schedules, not reduce payments.

The legislation filed today is in addition to the first phase of comprehensive pension reform the Governor and legislative leaders enacted last year that eliminates some of the most egregious abuses of the system. The Governor will soon file the second phase of pension reform. The improvements in this bill will help ensure that our pension systems are fair, sustainable and publicly credible. This is in the best interest of taxpayers, government and public employees.

Municipal Early Retirement Plan

The Governor today sent a letter to the Committee on Municipalities requesting it include additional proposals in a municipal relief package the committee is expected to report out shortly.

Among the Governor's new proposals is an optional Early Retirement Incentive program for cities and towns. The proposal is structured in a restrictive manner to ensure that desired near-term savings exceed the present value cost to the pension system while still giving city and town managers sufficient flexibility to structure the program in a manner that avoids adverse operating impacts. By making this program available at local option, it will give cities and towns the flexibility to determine for themselves whether this tool is appropriate for their community.

Under the terms of the plan, eligible employees must have at least 20 years of service and must be paid out of the municipality's operating budget. The number of participating employees shall be limited, with a strong consideration for the impact on municipal services and programs. Eligible employees would receive a maximum of three years of additional age or creditable service, or a combination of the two, the sum of which may not be greater than three.

Other tools include:

- Allowing regional school districts to share superintendents, providing savings and efficiencies, and
- Streamlined procedures allowing regional school districts greater access to their stabilization funds, assisting regional districts in coping with continued budget challenges.

The Governor is also proposing a study commission to perform a comprehensive evaluation of local aid formulas. Additionally, he is including $250,000 in the FY11 budget he will release next week to support the technical work of a Chapter 70 commission to review the foundation formula for education funding.

Also in the budget, the Governor will propose freezing special education private placement rates; relief from library "maintenance of effort" requirements and decertification rules; and authorization for local government to procure energy from state energy resource contracts.

Green Communities Grant Program

In addition to the tools the Governor outlined today, he also announced that the first round of Green Communities Grants will be available this fiscal year to help finance municipal energy efficiency and renewable power projects in eligible communities.

The new Green Communities Grants are funded with proceeds from auctions of carbon emissions permits under the Regional Greenhouse Gas Initiative (RGGI). Following a two-step application process, during which cities and towns must first apply for designation as Green Communities, the state's Department of Energy Resources (DOER) plans to make the first round of up to $7 million in Green Community Grant awards in late June. Qualified communities will be eligible for awards of up to $1 million each during the initial grant round.

"Green Communities Grants will help cities and towns finance targeted investments in energy efficiency and locally generated renewable power. We look forward to funding a robust first round of projects that capitalize on green energy opportunities, save taxpayers money and reduce environmental impacts in local communities," said Energy and Environmental Affairs Secretary Ian Bowles, whose office includes the DOER.

As a first step in the grant process, DOER will take applications between January 22 and May 14 from cities and towns seeking official Green Community status. Technical assistance grants awarded by the DOER last year have helped cities and towns prepare to meet the five grant eligibility benchmarks set by the Green Communities Act. To qualify, municipalities must meet these five criteria:

- Adopt local zoning bylaw or ordinance that allows "as-of-right-siting" of renewable energy projects;
- Adopt an expedited permitting process related to the as-of-right facilities;
- Establish a municipal energy use baseline and establish a program designed to reduce baseline use by 20 percent within five years;
- Purchase only fuel-efficient vehicles for municipal use, whenever such vehicles are commercially available and practicable; and
- Require all new residential construction over 3,000 square feet and all new commercial and industrial real estate construction to reduce lifecycle energy costs (i.e., adoption of an energy-saving building "stretch code").

While to date none of the Commonwealth's 351 cities and towns has met all five criteria for Green Community designation, DOER's Green Communities Division has worked closely with municipalities across the state for the past year and it is expected that several may be able to fulfill the requirements between now and the end of the traditional Town Meeting season this spring.

Newton and Cambridge have already adopted the stretch code and it will be on the Town Meeting warrant of at least four towns this spring. Once cities and towns are designated Green Communities, they are eligible to apply for Green Communities Grants, with applications due to the DOER at the end of May and awards anticipated in late June.

Since taking office, Governor Patrick and Lieutenant Governor Murray have partnered with local officials, strengthening communities across Massachusetts. The Patrick-Murray Administration has proposed and signed into law parts of the Municipal Partnership Act, providing communities with ways to lower health care and pension costs, generate additional revenue to relieve pressure on the property tax and streamline operations to make local government more efficient and responsive to its residents.

Amidst the greatest fiscal crisis to strike the nation since the Great Depression, the Patrick-Murray Administration has prioritized local communities, holding local education aid harmless despite a loss of $4 billion in state tax revenues and mitigating cuts to other local government aid.

The Governor will file his budget on Wednesday, January 27 th.

Click here to view Community by Community Unrestricted Local Aid

PATRICK-MURRAY ADMINISTRATION ANNOUNCES AWARD OF LARGEST-EVER STATE CONTRACT FOR INSTALLATION OF SOLAR POWER

Contracts for over 4 megawatts of federal stimulus-funded solar power at water and wastewater treatment plants go to team of North Andover and Taunton firms

NORTH ANDOVER - Friday, February 5, 2010 - As part of the Patrick-Murray Administration's Massachusetts Recovery Plan, Governor Deval Patrick today announced the award of federal stimulus-funded contracts to install 4.1 megawatts (MW) of solar energy at 12 public water and wastewater treatment facilities throughout the Commonwealth. These projects will help to reduce energy bills and greenhouse gas impacts while creating jobs and growing the state's solar industry. The 12 contracts represent the state's largest-ever award for solar installation at public facilities.
Worth approximately $20 million in ARRA funding, the projects announced today are expected to be complete between June 2010 and July 2011. They include municipal and regional facilities in Ashland, Hyannis, Chelmsford, Easton, Fairhaven, Falmouth, Holden, Marlborough, Blackstone/Millbury, East Freetown, Pittsfield and Townsend.

Governor Patrick made the announcement at the North Andover logistics center of Nexamp Inc., a four-year old veteran-founded clean energy company that employs 45 skilled workers - including many veterans - up from just six employees in 2006. Nexamp and its partner, Florence Electric of Taunton, won the contracts through a competitive solicitation by the Department of Energy Resources (DOER).

"Over the past three years, we have built a vibrant solar industry in Massachusetts - quadrupling the number of companies and more than doubling the number of jobs in the solar energy sector," Governor Patrick said. "The projects we're announcing today continue that success - putting federal stimulus dollars to work installing solar panels that will produce clean, renewable power for municipalities within a few short months."

"This investment will help sustain our high clean drinking water standards without using so much energy. Facilities throughout our state can continue to ensure our water is clean and safe, reduce harmful greenhouse gas emissions, and help put people back to work," said Senator John Kerry.

"One of the many important and farsighted aspects of the Recovery Act is that it enables cities and towns to modernize their aging infrastructure in a way that simultaneously increases their energy efficiency and helps reduce the strain on their municipal budgets. Furthermore, these federal dollars will put people to work all across the Commonwealth in a manner envisioned by the Green Jobs Act, which I co-authored in 2007. I am pleased that a company located in North Andover, which I have the privilege of representing, will be taking the lead on such a worthy effort," said Congressman John F. Tierney.

"These investments will not only help communities reduce their energy costs, but will help stimulate the economy and create jobs," said Congressman William Delahunt. "I want to commend the Falmouth Board of Selectmen, Barnstable Town Manager John Klimm and Public Works Director Mark Ells for their strong support for these important renewable energy projects."

"Today's announcement will improve water infrastructure in Chelmsford while simultaneously creating local jobs," said Congresswoman Niki Tsongas. "This is a good investment in the town and I thank Governor Patrick for his ongoing efforts to expand the Commonwealth's clean energy portfolio."

"Nexamp is honored to be selected through this highly competitive process to design and install these important solar projects. We look forward to optimizing the Massachusetts solar stimulus funding to provide long-term savings to each of the sites while creating skilled, green-collar jobs," said Dan Leary, President and Chief Operating Officer at Nexamp.

Once complete, the solar projects will enable the 12 water and wastewater facilities to save nearly $650,000 per year by cutting conventional energy use by approximately 4.5 million kilowatt hours annually - roughly equal to the energy needed to power 600 households per year.

The 12 projects are funded out of $185 million in federal stimulus dollars awarded to Massachusetts by the U.S. Environmental Protection Agency (EPA) to finance 127 water and wastewater infrastructure projects through the State Revolving Fund (SRF) administered by the Massachusetts Department of Environmental Protection (MassDEP). The American Recovery and Reinvestment Act (ARRA) requires that 20 percent of federal stimulus funds for SRF be used for "green infrastructure" improvements at water and wastewater treatment plants - facilities that account for nearly one-third of energy use by Massachusetts cities and towns.

Massachusetts was the first state to get EPA approval to use SRF funding for energy efficiency and renewable energy activities. In fact, the Commonwealth's Energy Management Pilot served as a model for the 20 percent SRF green infrastructure requirement in the ARRA.

"The projects announced today not only create clean energy jobs, but also tackle a big environmental challenge. Drinking water and wastewater treatment plants are vital for protecting water quality and human health, but are also huge municipal energy users with a big carbon footprint," Energy and Environmental Affairs Secretary Ian Bowles said. "When Governor Patrick combined energy and environment in one secretariat, we set out to make these facilities both energy efficient and producers of on-site clean energy. In so doing, we created a national model that the Recovery Act has spread to all 50 states."

"This commitment to on-site power generation will bring these municipal facilities closer to achieving zero net energy status, resulting in long-term energy cost savings," said MassDEP Commissioner Laurie Burt. "By participating, these facilities are also setting the 'green' example for the other treatment plants across the Commonwealth to follow."

"With these 12 projects - the largest single solar procurement in the Commonwealth's history - the state is partnering with cities and towns to make good on Governor Patrick's promise of a clean energy future," said DOER Commissioner Phil Giudice.

Solar PV installations are slated for the following locations:

- Ashland Ponderosa Public Works Facility
- Barnstable Wastewater Treatment Facility (Hyannis)
- Chelmsford Crooked Spring Water Treatment Facility
- Easton Water Division
- Fairhaven Wastewater Plant
- Falmouth Crooked Pond Water Filtration Facility
- Massachusetts Water Resources Authority Carroll Water Treatment Plant (Marlborough)
- New Bedford Water Division Quittacas Water Plant (East Freetown)
- Pittsfield Wastewater Treatment Plant
- Townsend Water System
- Upper Blackstone Wastewater Pollution Abatement District Regional Wastewater Plant (Blackstone and Millbury)
- Worcester Water Filtration Plant (Holden)

The contracts announced today are part of the Patrick-Murray Administration's Massachusetts Solar Stimulus program - a plan to use ARRA funding to expand the Commonwealth's solar power capacity by up to 13 MW. In addition to the water and wastewater treatment facility projects, plans are underway to install solar PV at a variety of public facilities across the state including colleges, housing projects and transportation facilities.

By the end of 2010, Massachusetts will see a nearly 20-fold increase in solar installations. ARRA-funded solar installations on water and wastewater treatment facilities, and other public buildings and PV projects assisted by Commonwealth Solar rebates will bring the state to approximately 63 MW by the end of 2010, up from 3.5 MW when Governor Patrick took office. More than 18 MW of solar power are currently up and running across Massachusetts.

The Patrick-Murray Administration's emphasis on solar power is having a significant impact on the Commonwealth's solar power industry. Since the launch of Commonwealth Solar in January 2008, the number of installation contractors and subcontractors has quadrupled from roughly 50 to nearly 200. And a recent survey of 98 solar PV manufacturers, integrators and installers revealed that they doubled their

Massachusetts employment in one year - 1,086 to 2,075 - from year end 2007 to 2008, and expected to add another 960 employees in 2009. Eighty percent of these firms added employees in 2008, and all but 11 planned to expand their workforce in 2009.

"This is a win-win for everyone," said Senator Marc R. Pacheco, Senate Chair, Joint Committee on Federal Stimulus Oversight. "Twelve facilities will improve their energy efficiency, which will reduce greenhouse gases and will create 'green jobs.' This is a large step forward for Massachusetts improving its alternative energy use and getting people back to work. I am especially pleased that a company right from my own district is embracing this clean energy movement and is taking advantage of the economic opportunities it presents."

"Amidst concerns that stimulus funds are primarily creating public sector jobs, this project is an example of making targeted investments in private companies that will sustain business in the private sector and provide a long term benefit for the public," said Representative David P. Linsky, House Chair, Joint Committee on Federal Stimulus Oversight.

"Over the last few years, I've been fortunate to watch Dan Leary and Will Thompson, two North Andover High School graduates, develop effective clean energy solutions right here in our community," said Representative David Torrisi. "I am extremely proud of them and excited to witness a local company showing such tremendous success and growth. I congratulate the entire Nexamp team for their innovation, determination and leadership."

"'Going 'green' is not just a passing trend, but a smart and increasingly necessary strategy for maintaining healthy water sources and a thriving living environment," said Representative Stephen R. Canessa. "I commend the Governor and this North Andover-Taunton joint business venture for their promotion of energy conservation. The region - its people, its environment and its municipalities - will experience the positive short-term and long-term benefits of 'going green' through this grant initiative."

"As someone who has used solar energy to assist in heating my home for years, I am thrilled to see this award to a Taunton company who has taken the lead in solar energy in our area and who has brought green jobs to our community," said Representative James H. Fagan. "I believe this is the way of the future."

"This is another win-win for the people of the South Coast and the Commonwealth," said Representative Patricia A. Haddad, who represents a quarter of the City of Taunton. "It supports local businesses via private-public partnerships and at the same time further enhances our collective efforts in green technology. Congratulations to Florence Electric."

Investments in renewable energy are critical components of Governor Patrick'sMassachusetts Recovery Plan, which combines state, federal and, where possible, private efforts to provide immediate and long-term relief and position the Commonwealth for recovery in the following ways:

- Deliver immediate relief by investing in the road, bridge and rail projects that put people to work today and providing safety net services that sustain people who are especially vulnerable during an economic crisis;
- Build a better tomorrow through education and infrastructure investments that strengthen our economic competitiveness, prepare workers for the jobs of the future, and support clean energy, broadband, and technology projects that cut costs while growing the economy; and
- Reform state government by eliminating the pension and ethics loopholes that discredit the work of government and revitalize the transportation networks that have suffered from decades of neglect and inaction.

PATRICK-MURRAY ADMINISTRATION DESIGNATES COMMONWEALTH'S FIRST OFFICIAL "GREEN COMMUNITIES"

35 cities and towns across the state are ranked as clean energy leaders, eligible for municipal renewable power and energy efficiency grants

HOPKINTON - Tuesday, May 25, 2010 - Governor Deval Patrick today designated 35 cities and towns from the Berkshires to Cape Cod as the Commonwealth's first official "Green Communities" - a status that makes them eligible for $8.1 million in grants for local renewable power and energy efficiency projects. The projects promise to create green jobs and advance both municipal and state clean energy goals.
"I am pleased to honor the vision and hard work of our first group of official Green Communities," said Governor Patrick. "These pioneers are notable not only for their commitment to a cleaner, greener Massachusetts, but also for their diversity. From tiny towns to major cities and suburbs in all regions of the state, Massachusetts communities recognize the benefits, for the economy as well as the environment, of making clean energy choices."

"It's great to see so many communities dedicated to saving energy, making new construction as energy efficient as possible, and accommodating clean energy investment and jobs in support of a stronger, more sustainable future for Massachusetts," said Lieutenant Governor Timothy Murray.

"Taking the initiative to make the changes necessary to promote energy efficiency and encourage renewable energy is critical to a community's future both environmentally and economically. The cities and towns designated 'Green Communities' have taken this challenge seriously and succeeded in their efforts. They are examples I hope that other communities across the commonwealth will follow," said Senate President Therese Murray.

The signature program of the landmark Green Communities Act of 2008, the Department of Energy Resources' (DOER) Green Communities Grant Program uses funding from auctions of carbon emissions permits under the Regional Greenhouse Gas Initiative to reward communities that win Green Communities designation by meeting five clean energy benchmarks:

- Adopting local zoning bylaw or ordinance that allows "as-of-right-siting" of renewable energy projects;
- Adopting an expedited permitting process related to the as-of-right facilities;
- Establishing a municipal energy use baseline and a program designed to reduce use by 20 percent within five years;
- Purchasing only fuel-efficient vehicles for municipal use, whenever such vehicles are commercially available and practicable; and

- Requiring all new residential construction over 3,000 square feet and all new commercial and industrial real estate construction to reduce lifecycle energy costs (i.e., adoption of an energy-saving building "stretch code").

May 14 was the deadline for municipalities to apply for Green Community designation in order to qualify for the first round of $8.1 million in Green Communities grants. Today's Green Communities designees - Acton, Arlington, Athol, Andover, Becket, Belchertown, Cambridge, Chelmsford, Easthampton, Greenfield, Hamilton, Hanover, Holyoke, Hopkinton, Kingston, Lancaster, Lenox, Lexington, Lincoln, Lowell, Mashpee, Medford, Melrose, Montague, Natick, Newton, Northampton, Palmer, Pittsfield, Salem, Springfield, Sudbury, Tyngsboro, Wenham, and Worcester - have until June 4 to submit applications for grants that will be awarded in late June.

"These 35 cities and towns have already distinguished themselves as leaders," said Energy and Environmental Affairs Secretary Ian Bowles. "With the help of Green Communities grant funding, they'll be able to go further - saving energy costs for their residents, reducing the environmental impact of municipal operations, and validating the Commonwealth's reputation as a national clean energy leader."

"We are confident that these 35 municipalities - and the projects they will undertake with Green Communities grants - will serve as shining examples to the Commonwealth's other 316 cities and towns, all of which we hope will also work toward becoming Green Communities and reaching their clean energy goals in the months ahead," said DOER Commissioner Phil Giudice.

In addition to grant eligibility, each Green Community designated today will receive a Big Belly solar waste compactor, to be delivered by June 30 in time for the summer parks and beaches season. Purchased with DOER energy efficiency funding, Big Belly compactors can hold several times more trash and litter than similarly sized regular trash receptacles - thereby reducing the number of garbage truck trips required to empty them. Each municipality will also receive a certificate from the Commonwealth congratulating it on becoming an official Green Community.

DOER will take additional applications for Green Community designations and grants later this year. Click here for more information on DOER's Green Communities program.

GOVERNOR PATRICK HIGHLIGHTS GROWTH OF SOLAR INDUSTRY WITH VISIT TO SOLAR PHOTOVOLTAIC INSTALLATION

Massachusetts jobs in solar manufacturing, installation and service nearly tripled since 2007, survey shows

BOSTON - Thursday, August 19, 2010 - As part of the Patrick-Murray Administration's Massachusetts Recovery Plan to secure the state's economic future, Governor Deval Patrick today visited solar photovoltaic (PV) systems installed at Salem State University in Salem, where he highlighted dramatic growth in the Massachusetts solar PV industry since the launch of the Commonwealth Solar program in 2008.

The Patrick-Murray Administration's emphasis on solar power, spurred by Governor Patrick's goal of 250 megawatts (MW) installed by 2017 has catalyzed the growth of a vibrant solar industry in Massachusetts. According to a recent survey of clean energy companies conducted by the Massachusetts Clean Energy Center (MassCEC), employment in solar manufacturing, installation and services has nearly tripled since Governor Patrick first took office, from 1,200 jobs in 2007 to roughly 3,000 expected by the end of 2010. Solar manufacturing jobs alone have jumped from 750 in 2007 to 2,000 in 2010.

"Clean energy technology is a huge economic opportunity for Massachusetts, and our success in solar power is a prime example of that," said Governor Patrick. "We are using all the levers at our disposal to make solar power an option for residents, businesses, and institutions, and then meet the demand with Massachusetts-made products installed by Massachusetts workers."

"We are well on the way toward reaching Governor Patrick's 250 MW goal, and are reaping the benefits in jobs as well as clean energy," said Energy and Environmental Affairs Secretary Ian Bowles.

"It is because of the leadership of Governor Patrick and innovative programs like Commonwealth Solar that Massachusetts is seeing such astounding growth in its solar industry in hard economic times," said MassCEC Executive Director Patrick Cloney. "We are proud to see institutions such as Salem State working toward a clean energy future."

In 2009, Salem State completed the installation of a 68 kW PV array on Atlantic Hall, a dormitory built in 2004 on a former industrial brownfield site. The PV system was installed by Massachusetts-based Broadway Electrical, and was funded by MassCEC's Commonwealth Solar rebate program and by the Division of Capital Asset Management through Clean Renewable Energy Bonds (CREBs). Salem State is also in the process of installing another 148 kW solar PV system using funds from the American Recovery and Reinvestment Act.

Solar PV projects assisted by Commonwealth Solar rebates, as well as solar installations supported by

federal stimulus funds on water treatment facilities and other public buildings, will bring the state to more than 60 MW of solar power installed or under contract by the end of 2010, up from 3.5 MW when Governor Patrick took office.

Between January 2008 and December 2009, Commonwealth Solar's initial phase awarded nearly 1,300 rebates for residential, commercial and municipal projects capable of generating 23.5 MW of electricity - enough to power nearly 3,750 homes in Massachusetts. On the heels of that success, in late January MassCEC launched two new solar rebate programs - Commonwealth Solar II and Commonwealth Solar Stimulus. Funding for Commonwealth Solar Stimulus comes from $8 million in State Energy Program funding awarded to the Department of Energy Resources under the American Recovery and Reinvestment Act (ARRA). Commonwealth Solar Stimulus has awarded funds to 102 solar projects in Massachusetts for 7.8 MW of solar power. In addition, the Commonwealth awarded the largest solar installation contract in the state's history - $20 million for 4.1 MW of solar on waterworks facilities - early this year, funded by ARRA monies from the U.S. Environmental Protection Agency. In all, the Commonwealth has dedicated over $160 million of renewable energy and federal funds to support investment in solar energy totaling almost $330 million.

Going forward, a new Solar Credit program will support larger installations of solar PV in the future, while Commonwealth Solar II will continue to provide rebates for smaller residential and commercial systems.

GOVERNOR PATRICK ANNOUNCES WIND TURBINE BLADE MANUFACTURER TO LOCATE FACILITY IN FALL RIVER

TPI Composites will create at least 30 engineering and technical jobs; Future expansion planned

Governor Patrick cuts the ribbon for global wind blade manufacturer TPI Composites, Inc. (TPI) to open a Wind Blade Innovation Center in Fall River. (Photo credit: Matt Bennett/Governor's Office). View additional photos.

FALL RIVER - Wednesday, August 25, 2010 - As part of the Patrick-Murray Administration's Massachusetts Recovery Plan, Governor Deval Patrick today announced that global wind blade manufacturer TPI Composites, Inc. (TPI) will open a Wind Blade Innovation Center in Fall River.

The company, which is headquartered in Scottsdale, Arizona, will develop a 69,000 square foot wind blade research and development and prototype manufacturing center in Fall River, creating at least 30 engineering and technical jobs. TPI also plans a second phase of expansion doubling its space and production capacity at the site, and enabling the production of blades 70 meters or longer.

"I welcome TPI Composites to Massachusetts, where they become part of our growing wind energy industry," said Governor Patrick. "With facilities like the Wind Technology Testing Center and companies like TPI, Massachusetts will lead the nation in the next generation of wind energy technology."

"I am very proud to have played a role in working with the Governor's office in bringing TPI Composites to Fall River," said Congressman Barney Frank. "TPI and other companies can be assured that when they locate to our area they will have the full support of our elected officials as we work together to bring important jobs and economic development to Massachusetts."

"Governor Patrick's goal of 2,000 megawatts of wind power, on shore and offshore, by 2020 has already inspired a ten-fold increase in installed wind power since he took office," said Energy and Environmental Affairs Secretary Ian Bowles. "Companies like TPI are making wind energy not just a resource for Massachusetts but a vital new industry producing jobs and growth."

Clean energy jobs and installation have been priorities for Governor Patrick. By the end of this year, Massachusetts will have installed or contracted over 60 megawatts (MW) of solar power, a nearly 20-fold increase over the 3.5 MW installed statewide when Governor Patrick took office. According to a recent survey of clean energy companies conducted by the Massachusetts Clean Energy Center (MassCEC), employment in solar manufacturing and installation services has nearly tripled since Governor Patrick first took office, from 1,200 jobs in 2007 to roughly 3,000 expected by the end of 2010. Solar manufacturing jobs alone have jumped from 750 in 2007 to 2,000 in 2010, while the number of firms involved in solar installation has jumped from 30 to 200. Wind power has increased tenfold over four years, from 3.1 MW in 2007 to over 30 MW by the end of this year. Massachusetts firms engaged in development and manufacturing of wind turbines and their component parts include FloDesign, American Superconductor and Vestas Power Systems. Developers and installers of wind energy include First Wind and Solaya Energy.

To support this investment in Fall River, MassCEC has awarded TPI a $250,000 grant, contingent upon creating and maintaining 30 jobs. The facility, which has water access for the transportation of large-scale blades, will be able to initially handle blades up to 62 meters long. The Water Street facility was previously owned by one of TPI's founders, Neil Tillotson. In the mid-1970s through mid-1980s, TPI used the facility as part of its fiberglass boat building business. TPI expects to begin operations at the new facility in early 2011. As it develops new blades for customers, TPI will be a customer for the U.S. Department of Energy-backed Wind Technology Testing Center in Charlestown, which is expected to open for business in February 2011.

"Many thanks to Governor Patrick and the Massachusetts Clean Energy Center for providing support needed to make this investment possible," said Steve Lockard, President and CEO of TPI Composites, Inc. "We look forward to our Fall River facility being an integral part of the development of the wind energy sector in Massachusetts."

"Bringing a major wind blade manufacturer to the state to carry out development, testing and training for the advanced manufacturing of wind blades will help build the wind blade cluster in Massachusetts, and provide a local customer for our Wind Technology Testing Center," said MassCEC's Executive Director Patrick Cloney.

"The opening of this new TPI Composites location is very exciting for Fall River. Not only does it bring vital jobs to our city, but this reflects well for the region that we are doing something right to attract businesses on the cutting edge of sustainable technology," said Representative David B. Sullivan.

"I'm thrilled TPI Composites has chosen Fall River," said Representative Michael J. Rodrigues. "Their arrival represents a great opportunity for our South Coast to lead the way toward a vibrant, clean energy economy, bringing needed jobs to our region and providing our citizens with environmental benefits for generations to come."

TPI is a leader in both development and manufacturing of large-scale composite structures for the wind energy (wind blades), transportation and military vehicle markets. The company was founded in 1968 in Warren, Rhode Island, as a fiberglass boat builder, and continues to have operations there. In the late 1980s the company identified a superior manufacturing process for producing large composite parts while eliminating harmful VOC emissions, called Seeman Composites Resin Infusion Molding Process (SCRIMP), and purchased the rights to the process. In 2001, TPI entered the wind energy market. Today, TPI supplies wind turbine blades to the top wind turbine manufacturers in the world, with customers such as Mitsubishi and GE Energy, which together produced half of the US-installed wind energy capacity in 2009.

Created by the Green Jobs Act of 2008, the Massachusetts Clean Energy Center (MassCEC) has as its mission to foster the growth of the Massachusetts clean energy industry by providing seed grants to companies, universities, and nonprofit organizations; funding job training and workforce development programs; and, as home of the Massachusetts Renewable Energy Trust, supporting the installation of renewable energy projects throughout the state.

Patrick-Murray Administration Announces Clean Energy and Climate Plan to Reduce Greenhouse Gas Emissions 25 percent by 2020

Comprehensive plan to lower energy costs, increase energy independence and create clean energy jobs will meet the most ambitious emissions limit in the country

BOSTON - December 29, 2010 - Energy and Environmental Affairs (EEA) Secretary Ian Bowles today set the statewide greenhouse gas (GHG) emissions limit for 2020 required by the Global Warming Solutions Act of 2008 at 25 percent below 1990 levels, the maximum authorized by the Act, saying that measures already in place will get Massachusetts much of the way toward that goal. A targeted portfolio of additional policies, chosen because they promise overall cost savings, will allow the Bay State to reach the most ambitious target for GHG reduction of any state in the country, Secretary Bowles said. "Massachusetts has already taken great strides in energy innovation, sparking a clean energy revolution in the Commonwealth and getting us two-thirds of the way toward 25 percent lower emissions by 2020," said Secretary Bowles. "I am confident we will meet the 25 percent limit I set today with a portfolio of policies that build on reforms made to date, launch practical new initiatives on a pilot basis, and generate cost savings and jobs."

"The clean energy plan released today lays out an ambitious but practical framework to continue - and accelerate - the Commonwealth's transition to clean energy," said Secretary of Energy and Environmental Affairs-designate Rick Sullivan. "I look forward to maintaining this momentum as our state distinguishes itself as the national leader on clean energy and greenhouse gas emissions reductions."
The Global Warming Solutions Act (GWSA), signed by Governor Deval Patrick in August 2008, mandates the reduction of greenhouse gas (GHG) emissions 80 percent below 1990 levels by 2050, and requires the Secretary of Energy and Environmental Affairs to set a legally enforceable GHG emissions limit for 2020 of between 10 percent and 25 percent below 1990 levels by January 1, 2011, and to issue a plan for achieving those reductions while growing the clean energy economy. Secretary Bowles set the limit today at the statutory maximum of 25 percent and released the Clean Energy and Climate Plan for 2020, which contains a portfolio of policies designed to meet the limit.

In his formal determination of the 2020 emissions limit, Secretary Bowles noted that "established state policies to promote energy conservation and cleaner energy sources are expected to produce GHG

reductions of 18 percent below 1990 levels by 2020," and that the remaining question before him in making the determination was "where in the remaining statutory range of 18 to 25 percent reduction it is practical and appropriate to set the 2020 limit. Central to that question is what additional actions of policy, regulation, and legislation could be pursued that would achieve additional emissions reduction by 2020 and beyond." Though he considered "a wide range of measures," Secretary Bowles included in the implementation plan for 2020 "only those additional measures that provide significant energy cost savings and create clean energy jobs," but those he found sufficient to support the maximum emissions reduction requirement of 25 percent.

"This limit, together with the portfolio of GHG mitigation measures presented in the Clean Energy and Climate Plan for 2020, is a substantial step forward in the Commonwealth's ongoing efforts to grow our clean energy economy, reduce energy costs, become energy independent and minimize climate change impacts to the citizens, environmental resources, and economy of Massachusetts," wrote Secretary Bowles.

The 136-page Clean Energy and Climate Plan for 2020 contains a "portfolio" of established and new measures that reduce energy waste, save money, and stimulate the adoption of clean energy technologies, thereby creating jobs at the same time that they reduce GHG emissions. It is estimated that 42,000 to 48,000 jobs would result from full implementation of the plan in 2020, both jobs that fill every niche in the clean energy supply chain - electricians, installers, researchers, architects, manufacturers, plumbers, energy auditors, technicians, and scientists - and jobs throughout the economy as lower fossil-fuel energy expenses lead to more spending on in-state goods and services.

Existing policies include the Green Communities Act requirement of capturing all cost-effective energy efficiency, which has given Massachusetts the most far-reaching energy efficiency program in the country, projected to yield $6 billion in customer savings from $2 billion of investment over three years. Continuation of these energy efficiency efforts, plus additional building-related measures such as deep-energy improvements in buildings; advanced, flexible building energy codes; and a new energy rating and labeling system that will be the equivalent of miles-per-gallon auto fuel efficiency ratings for buildings, beginning as a pilot program in western Massachusetts will reduce GHG emissions statewide nearly 10 percent by 2020.

In electricity supply, established programs like the Regional Greenhouse Gas Initiative and the Renewable Portfolio Standard will be supplemented by efforts to obtain additional clean energy imports such as Canadian hydropower and a proposed Clean Energy Performance Standard, which would require electricity suppliers to favor lower- and no-emissions sources in the mix of electricity delivered to their customers, will reduce emissions 7.7 percent by 2020. In transportation, MassDOT's recently announced GreenDOT sustainability program and other efforts to limit growth in driving, federal fuel

efficiency standards, lower-carbon fuels, and potential incentives for clean cars to be studied and piloted are expected to produce 7.6 percent GHG reductions. And in non-energy related sources of emissions, new and expanded programs will address leaking refrigerants that are more powerful greenhouse gases than carbon dioxide, for additional reductions of 2 percent.

"This is wonderful news," said Senator Marc Pacheco, Chairman of the Senate Committee on Global Warming and Climate Change. "This target is not only good for the environment, but is also good for our public health and security, and will put us on the path to revolutionizing our economy by spurring job growth and sparking innovation in renewable energy and green technologies. This emissions reductions target demonstrates the Patrick-Murray Administration's commitment to fully implementing the intent of the Global Warming Solutions Act. As the author of this legislation, I always knew it was possible to implement such strong measures and I applaud Secretary Bowles and the rest of the Administration for taking this bold step toward combating climate change."

"I commend Secretary Bowles and the Advisory Committee's hard work and dedication to set the Commonwealth on track for reducing emissions and fostering development of clean energy," said Representative Frank Smizik, Chairman of the House Committee on Global Warming and Climate Change. "It is imperative for the strength of our economy, our national security, and our health to address the harmful impacts of greenhouse gases and climate change. I look forward to working with the Administration to continue to push the envelope with new innovations and strong standards, so that the Commonwealth can continue to be a national leader and achieve the ultimate goal of an 80 percent reduction in greenhouse gas emissions as soon as possible"

Secretary Bowles's determination, and the Clean Energy and Climate Plan for 2020, were both informed by a series of eight public hearings held around the state and by input from the Climate Protection and Green Economy Advisory Committee, a body created by the Global Warming Solutions Act that includes representatives of the following sectors: commercial, industrial and manufacturing; transportation; low-income consumers; energy generation and distribution; environmental protection; energy efficiency and renewable energy; local government; and academic institutions.

"It has been a privilege to collaborate with such a representative group of stakeholders in determining ways to build a clean energy economy," said co-chair Susan Avery, President and Director of the Woods Hole Oceanographic Institution. "I look forward to continuing this effort and helping to support the important goals of this ambitious plan."

"The Massachusetts Clean Energy and Climate Plan for 2020 is a big step forward towards moving Massachusetts towards a Green Economy," said co-chair Martin Madaus, former CEO of Millipore Corp. "This comprehensive plan is the result of about two years of outstanding work by many experts and has received thorough input from all stakeholders through the Climate Protection and Green Economy

Advisory Committee."

"The vision presented in this report is both bold and well-grounded in the facts and opportunities we face," said Conservation Law Foundation (CLF) President John Kassel. "It will serve the citizens and economy of Massachusetts, and New England, well. It took a lot of courage to put this out there. It will take even more courage, and determination, to make it happen. We at CLF look forward to helping it become a reality."

"These strong and realistic goals for GHG reductions in the Commonwealth are welcomed by the rapidly growing Massachusetts clean energy industry," said Peter Rothstein, President of the New England Clean Energy Council. "The GHG reductions achieved in the last few years, and the combination of clear policies and new private sector innovations and investments are laying a path to cost-effectively meet these environmental goals while providing sustainable, economic growth."

"This Clean Energy and Climate Plan is the latest example of Governor Patrick's commitment to growing clean energy jobs in Massachusetts," said Marty Aikens of the International Brotherhood of Electrical Workers Local 103. "It is a practical roadmap that shows that measures to decrease emissions can lead to thousands of new jobs."

The Secretary's 2020 Greenhouse Gas Limit Determination, the full Clean Energy and Climate Plan for 2020, the Executive Summary of the Plan, and a letter to EEA Secretary Bowles from the co-chairs of the Climate Protection and Green Economy Advisory Committee can be viewed here.

MASSACHUSETTS RANKED FIRST IN THE NATION FOR ENERGY EFFICIENCY

Governor Patrick's clean energy agenda cited as Massachusetts tops California in ACEEE's State Energy Efficiency Scorecard

Click here to read the full report online

WASHINGTON, D.C. –Thursday, October 20, 2011 – Governor Deval Patrick today joined the American Council for an Energy-Efficient Economy (ACEEE) to announce Massachusetts has been named number one in ACEEE's annual state-by-state energy efficiency scorecard. Massachusetts topped California in the ranking for the first time, thanks to the Patrick-Murray Administration's clean energy agenda, which includes the Green Communities Act of 2008 and other innovative programs and policies to save energy and create jobs. Governor Deval Patrick accepted the honor and offered remarks at a ceremony at the National Press Club in Washington, D.C. this morning.

"Thanks to our investments in innovation and infrastructure, Massachusetts is now leading the nation in energy efficiency," said Governor Patrick. "Through our Green Communities Act, we set aggressive goals and laid the foundation for greater investment in energy efficiency – and now we are proud to be a model for the nation and world."

California held the top slot on the national scorecard for the first four years. ACEEE ranked Massachusetts number four in 2006, but the Bay State climbed to number two in 2009 and held that slot for two years, before moving up to number one today.

ACEEE says Massachusetts now has the most aggressive energy efficiency targets in the nation, citing the Green Communities Act as central to Massachusetts' success. ACEEE also pointed to the effectiveness of the Patrick-Murray Administration's integrated approach to creating jobs, helping clean energy businesses thrive, improving energy security and lowering energy costs, and reducing Greenhouse Gas emissions. In addition to the Green Communities Act, the Governor has also signed the Green Jobs Act and Global Warming Solutions Act. ACEEE calculated scores based on utility efficiency programs and policy, transportation, building energy codes, combined heat and power projects, state government initiatives, and appliance efficiency standards.

"Massachusetts has a long record of success implementing energy efficiency programs," said ACEEE in its report. "The state took a major leap forward in 2008, however, when it passed the Green Communities Act , which established energy efficiency as the state's 'first-priority' resource, creating an Energy Efficiency Advisory Council to collaborate with utilities to develop statewide efficiency plans in three-year cycles. The three-year plan in operation aims to achieve electric savings equal to 2.4 percent and natural gas savings equal to 1.5 percent of sales in 2012, which amounts to the most aggressive EERS target in the nation. The Green Communities Act is ultimately expected to lead to an investment of $2.2 billion in energy efficiency and demand resources between 2010 and 2012."

“Under the leadership of Governor Patrick, our policies have positioned Massachusetts as a leader in energy efficiency adoption and it’s no accident we’ve received this honor,” said Energy and Environmental Affairs Secretary Rick Sullivan. “I’m proud of the work we’ve done with our legislative, utility, environmental partners, and communities to reach our collective statewide energy efficiency goals.”

The Department of Energy Resources’ (DOER) Green Communities Designation and Grant Program, which is a result of the Green Communities Act, uses funding from auctions of carbon emissions permits under the Regional Greenhouse Gas Initiative to reward communities that win Green Communities designation by meeting five clean energy benchmarks including adoption of energy efficient building and planning practices.

To date, 74 municipalities across the Commonwealth have become Green Communities and created savings equivalent to the annual energy consumption of approximately 12,978 New England households. In addition, 97 municipalities have adopted the new energy efficient stretch energy code.

The Green Communities Act also requires investor-owned utilities to pursue all cost-effective energy efficiency – making energy efficiency Massachusetts’ “first fuel” for meeting energy demand. In 2010, the first implementation year, the utility energy efficiency plans saved an equivalent to the annual electricity usage of almost 85,000 households and the equivalent to the annual natural gas usage of nearly 14,000 households. In addition, measures implemented under the plans produced greenhouse gas emissions reductions equal to eliminating more than 74,000 cars.

"By making energy efficiency Massachusetts' first fuel, thousands of people - from contractors and homeowners to businesses and municipalities - are benefiting from our strategic energy efficiency investments,” said Department of Energy Resources Commissioner Mark Sylvia. “We are demonstrating what’s possible and building on a history of leadership as we improve our codes, incentives, and infrastructure across the state. We are proud to be recognized by ACEEE today.”

“This ranking affirms the policy choices Massachusetts has made: prioritizing cost-effective energy efficiency as the lowest cost, cleanest energy resource, emphasizing the importance of a strong, diverse stakeholder council, and committed program administrators,” said Daniel Sosland, Executive Director of ENE (Environment Northeast). ENE represents the environmental community on the state’s Energy Efficiency Advisory Council.

"The success of the Massachusetts program proves that customers will respond when programs show results that save energy end reduce costs at the same time," said Robert A. Rio, Senior Vice President for Government Affairs at Associated Industries of Massachusetts, who represents industry on the state Energy Efficiency Advisory Council that developed the Commonwealth's three-year energy efficiency plans.

“Energy efficiency is America’s abundant, untapped energy resource and the states continue to press forward to reap its economic and environmental benefits. The message here is that energy efficiency is a pragmatic, bipartisan solution that political leaders from both sides of the aisle can support," said ACEEE Executive Director Steven Nadel. "As they have over the past decades, states continue to provide the

leadership needed to forge an energy-efficient economy, which reduces energy costs, spurs job growth, and benefits the environment."

Earlier this week, the Massachusetts Clean Energy Center (MassCEC) reported the Commonwealth's clean energy companies grew jobs at a rate of 6.7 percent from July 2010 through July 2011 in its 2011 Massachusetts Clean Energy Industry Report.

GOVERNOR PATRICK VISITS SOLARCITY TO HIGHLIGHT CLEAN ENERGY INDUSTRY

Clean energy company has added 33 employees this year, and expansion will add 25 more

Governor Patrick celebrates the grand opening of SolarCity Corporation's Marlborough location. (Photo: Eric Haynes / Governor's Office). View additional photos.

MARLBOROUGH – Tuesday, May 1, 2012 – Governor Deval Patrick today celebrated the expansion of clean energy company SolarCity in Marlborough, where the company plans to add 25 jobs. The job growth is attributed to the Patrick-Murray Administration's investments in the clean energy economy including the Green Communities program.

"We have developed a nation-leading clean energy agenda because it is the right thing to do for our environment, our energy independence and our public health," said Governor Patrick. "The growth of private companies like SolarCity is a sign that our investment strategy in the clean energy industry is working."

SolarCity, a clean energy services company, expanded into Massachusetts in 2011. In less than a year, the company has tripled its workforce adding 33 employees to date and is adding 25 more positions at its new location. The Marlborough expansion more than doubles the company's warehouse square footage, combining the 6,000 square feet in facilities the company held in Billerica and Raynham.

The Massachusetts Clean Energy Center's *2011 Massachusetts Clean Energy Industry Report* showed a 6.7 percent growth in Massachusetts clean energy jobs between July 2010 and July 2011, with companies projecting continued growth in the year ahead. The report found nearly 5,000 companies engaged in clean energy work and employing more than 64,000 clean energy workers.

"Massachusetts is home to clean energy companies specializing in technologies ranging from energy efficiency and energy storage to efficient lighting and biofuels and we're proud they've made Massachusetts home," said Energy and Environmental Affairs Secretary Richard K. Sullivan. "The clean energy industry is growing and we're here today to celebrate it."

"Massachusetts has invested in the clean energy economy – and that investment is paying off with jobs and lower energy costs," said SolarCity's Regional Director for Massachusetts Ed Steins. "We have tripled our local staff in less than a year and are hiring for more positions in Massachusetts right now."

With these latest designations, 42 percent of Massachusetts residents or 2.7 million people now live in Green Communities across the Commonwealth. All of the 86 Green Communities committed to reduce their municipal energy consumption by 20 percent. This commitment collectively equates to the annual energy consumption of more than 13,000 Massachusetts homes and the greenhouse gases from more than 16,800 cars.

Under the Global Warming Solutions Act, Massachusetts has set the strongest greenhouse gas reduction targets in the nation – 25 percent below 1990 levels by 2020 and 80 percent by 2050. The implementation of the state's Clean Energy and Climate Plan for 2020 is estimated to create at least 42,000 jobs.

GOVERNOR PATRICK ANNOUNCES GREEN COMMUNITIES MILESTONE

Over 100 cities and towns named Green Communities; Seventeen cities and towns named clean energy leaders in fifth round of designations

Governor Patrick offers remarks during an event marking a Green Community milestone.(Photos: Jeremiah Robinson / Governor's Office) View additional photos.

Map of Green Communities

BOSTON – Tuesday, July 24, 2012 – Governor Deval Patrick today joined state and local officials to announce that Massachusetts is now home to over 100 Green Communities. At an event at the State House, the Governor announced the designation of 17 new Green Communities, bringing the total number up to 103 cities and towns. Nearly half of Massachusetts residents, or 44 percent, now live in a Green Community.

With the Department of Energy Resources' (DOER) designation, Amherst, Ashland, Auburn, Berlin, Conway, Gill, Great Barrington, Huntington, Lakeville, Leominster, Northfield, Pelham, Richmond,

Sunderland, Tisbury, Townsend, and West Tisbury will be eligible for nearly $2.75 million in grants for local renewable power and energy efficiency projects. Participating communities have committed to five clean energy leadership criteria – including cutting energy use by 20 percent over five years --spelled out in the nation-leading Green Communities Act, which was passed by the Legislature and signed by Governor Patrick in 2008.

When Governor Patrick came into office in 2007, he made an ambitious and achievable commitment to clean energy. A major component of that agenda is the Green Communities Act, which empowers communities to invest in local solutions that expand renewable energy adoption, boost the clean energy industry and cut overall energy use. As a result, Massachusetts leads the nation in energy efficiency and has seen the number of renewable energy projects – like solar and wind – soar. There are now more clean energy companies and clean energy jobs in Massachusetts than ever before.

“Surpassing the 100th Green Community mark is a win for every community and our Commonwealth as a whole,” said Governor Patrick. “We have developed a nation-leading clean energy agenda because it is the right thing to do for our environment, our energy independence and our public health. This milestone proves again the clean energy revolution is taking hold, and growing, one community at a time.”

“From Great Barrington in Berkshire County to Tisbury in Dukes County, our communities are committed to promoting clean energy and a green environment,” said Lieutenant Governor Timothy Murray. “Now over 100 Green Communities are making strategic investments to increase energy efficiency and create jobs, improving our economy and quality of life across Massachusetts.”

“I am so proud to hear that Massachusetts is now home to 103 Green Communities,” said House Speaker Robert A. DeLeo. “Adopting clean energy solutions in over a hundred of our cities and towns enhances the economy by creating more green jobs, giving new life to renewable energy companies, and cutting unnecessary energy usage.”

To date, the 103 Green Communities have committed to a total energy reduction equivalent to the annual energy consumption of 13,358 homes. This commitment equates to a greenhouse gas emissions reduction equivalent to taking 22,556 cars off the road.

“Cities and towns across the Commonwealth have stepped up to the challenge of decreasing our dependence on foreign sources of energy,” said Energy and Environmental Affairs Secretary Rick Sullivan. “Keeping our energy dollars in Massachusetts keeps more money in our wallets, boosting our economy, and not one overseas.”

DOER’s Green Communities Designation and Grant Program reward communities that win Green Communities designation by meeting five clean energy benchmarks:

- Adopting local zoning bylaw or ordinance that allows “as-of-right siting” – allowing a project to proceed without requiring a special permit or any time of discretionary approval – for renewable and/or alternative energy research and development facilities, manufacturing facilities or generation units;
- Adopting an expedited permitting process related to the as-of-right facilities;

- Establishing a municipal energy use baseline and a program to reduce use by 20 percent within five years;
- Purchasing only fuel-efficient vehicles for municipal use, whenever such vehicles are commercially available and practicable; and
- Requiring all new residential construction over 3,000 square feet and all new commercial and industrial real estate construction to reduce lifecycle energy costs (i.e. adoption of an energy-saving building "stretch code").

Once designated by DOER as official Green Communities, cities and towns are eligible for awards to fund local renewable power and energy efficiency projects that advance both municipal and state clean energy goals. Grants awarded so far assist an array of projects across the state, including the installation of solar panels on town office buildings, weatherization at schools and municipal buildings, installation of high-efficiency street lights, and a host of energy efficiency upgrades.

"With today's designation, the Commonwealth again demonstrates its commitment to supporting our municipalities while advancing our clean energy goals," said Senator Benjamin B. Downing, Senate Chairman of the Committee on Telecommunications, Utilities and Energy. "I am proud that communities I represent, Conway, Great Barrington and Richmond, join 100 other Green Communities in committing to these goals through reduced energy use and the encouragement of renewable energy solutions."

"I applaud the Administration for its leadership and investment in renewable energy and energy efficiency projects," said Representative John Keenan, House Chairman of the Committee on Telecommunications, Utilities and Energy. "The Commonwealth continues to lead the nation in promoting renewable energy and energy efficiency, and the Green Communities Program is at the forefront of that effort. Massachusetts' Green Communities are to be commended for their commitment to clean energy and energy efficiency projects."

"Nearly half of the Commonwealth's residents live in a community that has made a conscious decision to buck the energy status quo and become a leader in renewable energy adoption and smart energy use," said DOER Commissioner Mark Sylvia. "When we launched Green Communities just a few years ago, we never predicted such an overwhelming response. Becoming a Green Community requires hard work, and this milestone is a testament to the eagerness with which cities and towns large and small have rolled up their sleeves in support of a clean energy future."

Massachusetts sits at the end of the energy pipeline and imports all of its fossil-fuel based energy sources – some from areas unstable or hostile to the U.S. Of the $22 billion Massachusetts spends annually to buy the energy that runs its power plants, buildings and vehicles, 80 percent flows out of state to places like South America, Canada, and the Middle East. That's nearly $18 billion in lost economic opportunity that Massachusetts stands poised to reclaim through investments in home-grown renewable energy and energy efficiency projects such as those supported by Green Communities grants.

By the end of this month, Massachusetts will have more than 118 megawatts of solar power. That's enough electricity to power more than 18,600 homes, and when compared with fossil fuel-generated

electricity, the equivalent of taking 9,750 cars per year off the road. Installations this summer alone are poised to be more than five times the total solar power installed in all of 2008. There has been a twenty-fold increase in wind energy to 61 megawatts in just four years, enough to power nearly 19,600 homes. By the end of this year, Massachusetts will be more than halfway to its 2017 goal of 250 megawatts, with five years left to hit the target.

Grants for the communities designated today will be funded by Alternative Compliance Payments (ACP) made by electricity suppliers who do not meet their Renewable Portfolio Standard obligation to purchase a sufficient percentage of renewable energy. Green Communities grants also receive funding from proceeds of carbon allowance auctions under the Regional Greenhouse Gas Initiative (RGGI).

Using a formula that caps awards at $1 million and provides each community with a $125,000 base grant – plus additional amounts based on other criteria, DOER notified the selected communities of their eligibility for the following funding:

CITY OR TOWN	**AMOUNT**
Amherst	$302,000
Ashland	$164,325
Auburn	$165,550
Berlin	$140,350
Conway	$139,650
Gill	$139,900

Great Barrington	$142,700
Huntington	$140,650
Lakeville	$158,275
Leominster	$245,575
Northfield	$143,750
Pelham	$138,100
Richmond	$137,300
Sunderland	$146,450
Tisbury	$140,925
Townsend	$156,825
West Tisbury	$143,250

In addition to grant eligibility, each Green Community designated today will receive a certificate from the Commonwealth and four road signs identifying it as an official Green Community.

Click here for more information on DOER's Green Communities program.

PATRICK-MURRAY ADMINISTRATION ANNOUNCES COMPREHENSIVE, NATION-LEADING ENERGY AUDITS FOR MASSACHUSETTS MILITARY BASES

$1.5 million for energy efficiency, renewable energy and enhanced energy security at six military bases statewide

BOURNE – Thursday, January 17, 2013 – Lieutenant Governor Timothy Murray today joined Energy and Environmental Affairs Secretary Rick Sullivan at the Massachusetts Military Reservation to announce $1.5 million in funding for a first-in-the-nation initiative that will include comprehensive energy audits of the state's six military bases.

An initiative of the Patrick-Murray Administration's Military Asset and Security Strategy Task Force, chaired by Lieutenant Governor Murray, the audits will build on the Commonwealth's leadership in clean energy, further align Massachusetts bases with the U.S. Department of Defense priorities and reduce energy consumption and costs.

"This is an excellent step forward, both for our valued military bases and for our energy goals in the Commonwealth," said Governor Deval Patrick. "I thank the Lieutenant Governor's Task Force for their innovative work and look forward to celebrating the results."

"Moving forward on these energy audits is a key example of the work the Task Force first set forth to complete," said Lieutenant Governor Murray, Chair of the Military Asset and Security Strategy Task Force. "The defense industry and our military bases rely heavily on energy, and it is critical that we develop innovative opportunities to enhance energy efficiency and deliver cost-savings for our bases."

The Military Asset and Security Strategy Task Force shares a goal with the U.S. Department of Defense, the nation's largest user of energy, to reduce energy costs at all military installations. To do so in the Commonwealth, the Massachusetts Department of Energy Resources (DOER) will procure a contractor to conduct a comprehensive review of each base, including assessing each base for their energy use; establishing opportunities for renewable energy installations on site; and exploring the possibility of microgrid integration. For more information, review the full scope of work on DOER's website,http://www.mass.gov/eea/docs/doer/massachusetts-military-bases-clean-energy-background.pdf

Funding for this program comes from the 2011 Alternative Compliance Payments (ACP) Spending Plan. ACPs are paid by electric retail suppliers if they have insufficient Renewable Energy Certificates to meet their compliance obligations under the Commonwealth's Renewable Portfolio Standard. DOER establishes the plan for the use of those funds to support clean energy development in Massachusetts.

“The Patrick-Murray Administration has made energy efficiency and renewable energy a priority in Massachusetts,” said Secretary Sullivan. “These audits will allow us to move forward with innovative energy projects at our bases, some of the largest energy users in the Commonwealth.”

"The National Association of State Energy Officials has conducted a six-month review of various states' efforts to aid the military in finding cost-effective, innovative solutions to modernizing energy infrastructure and making facilities more energy efficient and sustainable," said David Terry, Executive Director of NASEO. "While there are many fine examples, Massachusetts is poised to be the national leader with its comprehensive approach to aiding bases in evaluating their energy needs, identifying solutions, and facilitating implementation. It's another great Massachusetts partnership program that will enhance local economic development and at the same time support of the exceptional work of our nation's military personnel."

The Commonwealth’s six military bases are the Massachusetts Military Reservation on Cape Cod; Westover Air Reserve Base in Chicopee; Barnes Air National Guard Base in Westfield; Natick Soldier Systems Center in Natick; Fort Devens; and Hanscom Air Force Base.

In 2012, for the second consecutive year, Massachusetts was ranked the top state in the nation for energy-efficiency policies and programs by the American Council for an Energy-Efficient Economy (ACEEE). This distinction recognizes the Commonwealth’s ambitious energy agenda and accomplishments through the Green Communities Act, the Green Jobs Act and the Global Warming Solutions Act, all signed by Governor Patrick in 2008.

About the Military Asset and Security Strategy Task Force

Governor Patrick and Lieutenant Governor Murray have committed to supporting Massachusetts’ military bases. In February 2012, with the support of Governor Patrick, Lieutenant Governor Murray signed Executive Order #541 creating the Military Asset and Security Strategy Task Force. As chair of the Task Force, Lieutenant Governor Murray and Task Force members led meetings including tours, roundtable discussions and committee meetings in support of the state’s six military bases.

Over the last year, the Military Mission, Operations, Opportunities and Efficiencies Subcommittee of the Task Force, led by MassDevelopment and the National Guard, has joined base leadership to explore opportunities to achieve upgrades and efficiencies, including energy efficiencies, on each base.

In 2012, Lieutenant Governor Murray tasked MassDevelopment to collaborate with the UMass Donahue Institute and assess the economic benefits of Massachusetts’ six military installations including. The report found that more than 46,500 jobs directly and indirectly are related to our installations that have an estimated economic impact of more than $14.2 billion to Massachusetts.

To learn more about the Military Asset and Security Strategy Task Force, please visit:www.mass.gov/governor/militarytaskforce.

Supportive Statements

“Energy efficiency is intricately linked to our Nation’s national security. Massachusetts and, in particular, the Massachusetts Military Reservation in my district, are already leaders on this front and are committed to further developing their self-sufficiency,” said Congressman Bill Keating. “I applaud Governor Patrick and Lieutenant Governor Murray’s initiative to help Massachusetts Military Reservation and other bases throughout Massachusetts identify additional opportunities for renewable energy and clean technology integration. It will not only help our environment and surrounding communities, but will also support the longevity of these installations, which in turn contribute greatly to our local economies. I stand ready to assist the Governor and Lieutenant Governor in moving this initiative forward and thank them for their tireless efforts on behalf of our military families, communities, and bases.”

“Massachusetts is once again leading the way with state-of-the-art clean energy solutions, creating an opportunity for our military installations to serve as national models for efficiency and productivity," said Congresswoman Niki Tsongas. "I have worked with the Governor, Lieutenant Governor and their team to take important steps to ensure Massachusetts’ bases have a strong and bright future, and remain some of our military’s most innovative resources.”

“I strongly believe we must always be looking at innovative ways to save money and increase our energy efficiency," said Congressman Jim McGovern. "These new efforts, under the guidance of the Task Force chaired by Lieutenant Governor Murray, will allow our military bases to become more efficient while increasing their security---a winning combination for the Commonwealth and our military. I commend the Patrick-Murray administrative for their innovative, forward thinking leadership on this critical issue.

“This funding will allow us to take a close look at how we can reduce energy costs at all of our military bases in Massachusetts,” said Senate President Therese Murray. “The Massachusetts Military Reservation on Cape Cod has always displayed a strong commitment to this effort by taking advantage of their renewable energy options and other initiatives to reduce operational costs. The information gathered from these audits will help our bases continue their conservation efforts and promote energy efficiency in the Commonwealth.”

“These energy audits for military bases represent an exciting new innovation for the Commonwealth," said Senator Marc Pacheco. "I am pleased that we will be able to take a look at these bases and figure out ways to improve their energy consumption."

"The Massachusetts National Guard is excited to be part of Lt. Gov. Murray's team to develop and strengthen our state's military and civilian partnerships. This initiative will greatly benefit the commonwealth and secure a responsible future for all its military installations through the use of clean and cost effective energy," said Major General L. Scott Rice, The Adjutant General, Massachusetts National Guard. "It's a great opportunity to explore new missions and build partnerships that will further our individual and collective agency goals."

"Westover strives to be a good neighbor as we fulfill national security objectives," said Colonel Steven Vautrain, 439th Airlift Wing Commander at Westover Air Reserve Base. "Being as efficient as possible with our limited resources makes good sense from both budgetary and mission-impact standpoints. We look forward to continuing our positive relationship with the Commonwealth and exploring ways to save taxpayer money through energy conservation."

"The joint nature with which the commands at the Massachusetts Military Reservation on Cape Cod approach reducing energy consumption along with the design, development and installation of renewable energy projects is providing the Massachusetts Military Reservation with a diverse energy portfolio that will lead the installation toward its goal of energy reliability, redundancy and most importantly energy security," said Colonel Anthony Schiavi, Executive Director, Massachusetts Military Reservation. "This Clean Energy Assessment will be an important tool for us to use in advancing our programs to that end as well as explore other areas in a rapidly growing area of technology."

“Camp Edwards fully supports and applauds the efforts of Lt. Governor Murray and the entire Task Force for establishing the Clean Energy Project Team,” said Colonel Richard Crivello, Commander of Camp Edwards Army National Guard Training Site. "We enthusiastically look forward to working with the Project Team to find new and innovative ways to reduce our energy consumption and carbon footprint while continuing to provide modern necessary and compatible training facilities for our deploying Massachusetts Army National Guard and Northeast Region military units."

"The 104th Fighter Wing has a reputation of being an environmental steward; from our robust recycling programs to designing our infrastructure--integrating the newest in energy efficiencies, we are always looking for green-approaches to completing our mission of Homeland Defense," said Colonel James Keefe, 104th Fighter Wing Commander at Barnes Air National Guard Base. "We are excited to explore additional opportunities to decrease our carbon foot-print through collaborating with the Clean Energy Project Team and the Lt. Governor's office."

“We at Fort Devens welcome the opportunity offered by Massachusetts of having an external agency provide an assessment of our energy programs," said Lt. Colonel Steven F. Egan at Fort Devens.

"The Air Force is always looking at ways to reduce our operating costs, increase energy efficiency and reduce our environmental impact," said Colonel Lester Weilacher, Hanscom Air Force Base Commander. "We welcome this opportunity to explore such opportunities in partnership with the Commonwealth of Massachusetts.”

PATRICK-MURRAY ADMINISTRATION REACHES 2017 SOLAR ENERGY TARGET, SETS NEW GOAL

BOSTON – Wednesday, May 1, 2013 – Governor Deval Patrick today joined Energy and Environmental Affairs Secretary Rick Sullivan and other energy officials to celebrate 250 megawatts of solar energy installed – reaching the Patrick-Murray Administration's goal four years early – and announced a new goal of 1,600 MW by 2020.

"When we set ambitious goals and invest in achieving them, Massachusetts wins," said Governor Patrick. "The many businesses and homeowners who have taken advantage of cost effective renewable energy installations are helping to create both a safer and a more prosperous Commonwealth for the next generation."

"By working with our legislative and municipal partners throughout the Commonwealth, we have achieved an ambitious goal far ahead of schedule while also supporting the state's clean energy economy," said Lieutenant Governor Timothy Murray. "We will build on this momentum, and continue to invest in renewable energy to lead the nation in this growing industry."

Under Governor Patrick's leadership, the amount of solar energy installed has increased 80 times from the 3 MW installed in 2007. Massachusetts has established strong incentives for renewable energy production that have led to significant cost reductions in solar electricity, making clean energy more accessible to Massachusetts businesses and residents.

"This exciting announcement is a direct result of Governor Patrick's leadership in the clean energy revolution," said Secretary Sullivan. "The initiatives and incentives we have established in Massachusetts are saving residents money, creating jobs and protecting our environment."

"Massachusetts has a lot to celebrate, including the success we've had reducing the cost of solar," said Department of Energy Resources Commissioner Mark Sylvia. "Those businesses, cities and towns, and homeowners who invest in renewable energy will reap the benefits of stable, reliable costs from this clean, local source of electricity."

The Commonwealth's Renewable Portfolio Standard (RPS) Solar Carve-Out program has established a strong solar energy market in Massachusetts, with a current cap of 400 MW. As that target approaches, state energy officials are fast-tracking revisions to expand the program.

Residential solar electricity prices dropped 28 percent in Massachusetts in 2012, according to a report

issued by the Solar Energy Industries Association in March 2013. This was the second biggest drop in the nation last year.

In addition to strengthening the RPS, the Green Communities Act, signed by Governor Patrick in 2008, established the Green Communities designation and grant program that provides technical assistance and incentives to support solar development in the Commonwealth's municipalities. There are currently 110 designated Green Communities in the Commonwealth and nearly half of all Massachusetts residents live in a Green Community.

These targeted investments have led to economic growth and job creation. The Massachusetts Clean Energy Center's (MassCEC) 2012 Massachusetts Clean Energy Industry Report showed an 11.2 percent growth in Massachusetts clean energy jobs between 2011 and 2012. Nearly 5,000 clean energy firms employ more than 71,000 clean energy workers.

"The success of the solar industry and the clean energy sector as a whole is a testament to the commitment Massachusetts has made to become a renewable energy leader," said MassCEC CEO Alicia Barton. "While we celebrate the success of one goal, we're excited to tackle the next, creating more local jobs and keeping more energy dollars here at home."

The solar power installed in Massachusetts generates enough electricity to power more than 37,000 homes for a year, and when compared with fossil fuel-generated electricity, is the equivalent of eliminating the greenhouse gas emissions from nearly 26,000 cars a year.

When the new goal is reached, 1,600 MW of installed solar will generate enough electricity to power approximately 240,000 homes annually – the equivalent of 97 percent of Boston households – and reduce the greenhouse gas emissions produced by about 166,000 cars.

"The Solar Energy Industries Association (SEIA) applauds the Commonwealth's phenomenal success in attracting investment, innovative companies and jobs while driving down costs," said SEIA Senior Vice President of State Affairs Carrie Cullen Hitt. "Massachusetts ranks number seven in the nation for solar installations (2012) and number two for driving down costs, which dropped over 28 percent in 2012. We look forward to expanding this success with Governor Patrick and his team."

Massachusetts sits at the end of the energy pipeline, spending billions of dollars annually to import all of its fossil fuel based energy sources from places like South America, Canada and the Middle East. That is lost economic opportunity that Massachusetts stands poised to reclaim through investments in home-grown renewable energy programs.

05.01.13 250 MegaWatt Goal Reached

AS PREPARED:

Governor Deval L. Patrick

250 MegaWatt Goal Reached

Drydock Center

Wednesday, May 1, 2013

Good afternoon and thank you Secretary Sullivan for that warm introduction. And thank you all for being with us to celebrate this important milestone.

Our Administration is about investing in education, innovation and infrastructure. This approach has worked throughout our history – and is working here, today. It's how we shape our own future.

Five years ago, we took a fresh look at our energy future. Energy in Massachusetts has long been relatively costly. With no oil, coal or natural gas of our own, we are at the end of the pipeline and are subject to the whims of a global energy market. We bear the economic and environmental costs associated with finding, extracting and transporting fuels from all corners of the world.

So in 2007, I announced several goals related to clean energy. Despite having only 3.5 megawatts of solar electricity installed at the time, I set a target of hitting 250 megawatts of solar by 2017.

We installed more than 100 megawatts of solar power in 2012 alone – ranking us sixth last year in total capacity added.

Let me to help you visualize exactly what 250 megawatts of solar power looks like. It's enough electricity to power more than 37,000 homes for a year. When compared with fossil fuel-generated electricity, it's the equivalent of eliminating the greenhouse gas emissions from nearly 26,000 cars a year.

I'm proud to announce today we've hit that milestone – four years early.

We have achieved this goal thanks to the hard work by many people here today. I want to particularly thank Secretary Sullivan and the several commissioners from EOEEA.

Now, let's build on that momentum. Today I am announcing a new goal of 1,600 megawatts by 2020.

I have directed Secretary Sullivan and his team to take a fresh look at the incentives that have

successfully grown the solar industry in Massachusetts, and expand our solar carve-out program to ensure certainty for the financing world, affordability for consumers, and stability for the market.

We are ranked second lowest in installation, fourth in the nation for total jobs in the solar sector, and we have more than 200 solar installation companies now working in Massachusetts. These companies are among the nearly 5,000 clean energy firms employing nearly 72,000 people in the Commonwealth.

The point is: Strategic investments work. We can choose growth and wise environmental stewardship.

So, we will not let up. We will continue to work together. In that spirit, let me thank the many here who have coached, counseled and partnered with my team on these many initiatives. To my team, outstanding work. Where we lead the Nation, it's because of you. Thank you.

Appendix B:
Legislation and Other Government Documents

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Deval L. Patrick
GOVERNOR

Timothy P. Murray
LIEUTENANT GOVERNOR

Ian A. Bowles
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

December 28, 2010

DETERMINATION OF GREENHOUSE GAS EMISSION LIMIT FOR 2020

Pursuant to the Global Warming Solutions Act (Chapter 298 of the Acts of 2008, and as codified at M.G.L. c. 21N, "Chapter 21N") **I hereby establish a statewide greenhouse gas (GHG) emissions limit of 25 percent below statewide 1990 GHG emissions levels by the year 2020**. As detailed below, this legally binding statewide greenhouse gas emissions limit is consistent with the directives of the Massachusetts legislature as embodied in the Global Warming Solutions Act (GWSA) and Chapter 21N, the Climate Protection and Green Economy Act. In a separate report entitled Massachusetts Clean Energy and Climate Plan for 2020 also issued today pursuant to Chapter 21N, I have outlined a portfolio of policies designed to achieve the 2020 emissions limit established herein. Establishing this statewide GHG emissions limit and outlining the specific and practical policy measures that can achieve that limit is a milestone in the Commonwealth's ongoing efforts to create a vibrant clean energy economy, reduce energy costs for consumers, increase energy independence and contribute toward stabilizing our climate.

Background

Massachusetts is at the end of the energy pipeline, and our customers pay for that in increasing and volatile costs, and dependence on sources of energy outside our state and region. The global market is also showing greater demand for clean energy technology and services and Massachusetts has the entrepreneurial know-how, the venture capital, and the quality workforce to seize an enormous economic opportunity, and to address one of the most pressing environmental concerns of our era.

The international consensus on climate released in 2007 by the Intergovernmental Panel on Climate Change (IPCC) found that the "*warming of the climate system is unequivocal.*" There is broad agreement and very high confidence that the documented increase in greenhouse gas concentrations is changing the Earth's climate—not only raising average global temperatures

but more importantly altering regional and local climatic and weather patterns.[1] Our climate is already changing, and there is scientific consensus that the changes are largely due to the combustion of fossil fuels and other human activities that increase atmospheric concentrations of GHGs.

The ongoing debate in the scientific community is not about whether climate change will occur, but rather about the rate and extent to which it will occur, what the regional and local impacts will be, and what adjustments will be needed to address its impacts through adaptation or mitigation efforts. Changes to Massachusetts' climate have already begun and will continue over the course of this century.

Since GHG emissions are primarily and directly tied to the use of fossil fuels for energy, the best strategy against climate change is moving toward a clean energy economy of energy efficiency, renewable energy, and other non-emitting ways to meet our energy needs. With its unparalleled academic and technical resources, local sources of investment capital, and highly skilled workforce, Massachusetts is poised to lead the transition to a clean energy economy nationally and to disproportionately benefit from the economic development and jobs resulting from that transition. Taking action to reduce GHG emissions in Massachusetts can both set an example of climate change mitigation for the nation and jumpstart the growth of clean energy jobs in the Commonwealth.

The GWSA, passed by the Massachusetts Legislature in 2008 and signed into law by Governor Deval Patrick, was a clear directive to limit and reduce the emissions of GHGs in Massachusetts in response to the overwhelming scientific evidence concerning global climate change and to the economic opportunity for Massachusetts inherent in leading the transition to a clean energy economy. That legislative directive, the formulation of this GHG emissions limit for the year 2020, and the establishment of a series of GHG reduction mitigation measures as outlined in the *Massachusetts Clean Energy and Climate Plan for 2020* collectively constitute a strong commitment by the Commonwealth to reducing its contribution to global climate change, while seizing opportunities to lower energy costs and grow our clean energy economy.

Statutory Mandate

In August 2008, Governor Deval Patrick signed the GWSA into law; Chapter 21N became effective in November of that year. The core mandate of the GWSA is that the Secretary of the Executive Office of Energy and Environmental Affairs (EEA), in consultation with other State agencies and the public, set economy-wide GHG emission limits for Massachusetts that are:

- Between 10 percent and 25 percent below statewide 1990 GHG emission levels by 2020; and
- 80 percent below statewide 1990 GHG emission levels by 2050.

[1] IPCC (Intergovernmental Panel on Climate Change), 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Chapter 21N required that these emissions limits be established by January 1, 2011 and that a plan be created addressing how the emissions reductions will be achieved. Sections 3(a) and 14 of Chapter 21N also required the Massachusetts Department of Environmental Protection ("MassDEP") to determine, "*the statewide greenhouse gas emissions level in calendar year 1990 and reasonably project what the emissions level will be in calendar year 2020 if no measures are imposed to lower emissions other than those formally adopted and implemented as of January 1, 2009. This projection shall hereafter be referred to as the projected 2020 business as usual level.*"[2] MassDEP issued its *Statewide Greenhouse Gas Emissions Level: 1990 Baseline and 2020 Business As Usual Projection* on July 1, 2009.

In March 2009, I established a Climate Protection and Green Economy Advisory Committee to provide input on measures to reduce GHG emissions in accordance with the GWSA. As required by the GWSA, the Climate Protection and Green Economy Advisory Committee included members representing the following sectors: commercial, industrial and manufacturing; transportation; low-income consumers; energy generation and distribution; environmental protection; energy efficiency and renewable energy; local government; and academic institutions. Advisory committee meetings were held on May 11, 2009; September 16, 2009; February 5, 2010; June 14, 2010; and November 18, 2010.

On April 30, 2010, the consultant commissioned by the state to analyze clean energy and climate strategies, Eastern Research Group, submitted a report to the Advisory Committee, *Initial Estimates of Emissions Reductions from Existing Policies Related to Reducing Greenhouse Gas Emissions*. This report analyzed the expected GHG reductions through 2020 that would result from the policies and programs implemented or initiated since the beginning of the Patrick Administration.

On April 30, 2010, EEA issued a *Draft Climate Implementation Plan: A framework for meeting the 2020 and 2050 goals of the Global Warming Solutions Act*. In that *Draft Climate Implementation Plan*, I signaled my intention to set a 2020 emissions reduction requirement of 18 to 25 percent below 1990 levels and, for the plan to achieve this limit, to give greatest consideration to those measures that show potential for significant energy cost savings and job creation.

In May, 2010, Eastern Research Group submitted an additional report, *Cost-Effective Greenhouse Gas Mitigation in Massachusetts: An Analysis of 2020 Potential*. In this second report, I asked the consultants to consider additional GHG reductions (beyond those already in place) that would be possible with further cost-effective policies.

Chapter 21N directed me to analyze the feasibility of measures such as electric generating facility aggregate limits, direct emissions reduction measures in various sectors of the economy, alternative compliance mechanisms, market-based compliance mechanisms, and the use of potential monetary and non-monetary incentives to achieve the emissions reduction limit.

A total of eight public hearings were held in June 2010 to solicit comment on the *Draft*

Climate Implementation Plan. Nearly 200 individuals and organizations provided oral or written comment on the 2020 emissions reduction requirement and on measures to meet the requirement.

Analysis conducted by the staff of my agencies pursuant to the requirements of Chapter 21N and information gathered from the Climate Protection and Green Economy Advisory Committee, the public hearings, and written public comments were all used to advise me in the preparation of the final *Massachusetts Clean Energy and Climate Plan for 2020.* The *Massachusetts Clean Energy and Climate Plan for 2020*, issued separately, outlines a range of proposed measures to be adopted, in whole or in part, by the Commonwealth.

Findings of Fact

In accordance with Section 4 of Chapter 21N, I make the following findings:

- I have considered relevant information pertaining to GHG emissions reduction programs in other states and nations when establishing the emissions reduction limit and selecting GHG reduction portfolio measures;
- I have considered and evaluated the total potential costs and economic and non-economic benefits of various reduction measures to the economy, environment and public health. Analyses have been conducted using the best available economic models, emissions estimation techniques, and other scientific measures;
- I have identified opportunities for emissions reduction measures from all verifiable and enforceable voluntary actions and incorporated them into the *Massachusetts Clean Energy and Climate Plan for 2020* as applicable;
- I considered establishing emission limits by sources or categories of sources as well as *de minimis* exemptions from such limits, but rejected this approach as inconsistent with the preference I have expressed for measures that result in cost savings and/or job growth.
- A series of public hearings was held in accordance with the provisions of M.G.L. c.30A to solicit input on the proposed 2020 GHG emissions limit and a draft version of the implementing plan. As directed in the GWSA, a portion of these hearings were held in regions that have the most significant exposure to air pollutants, including, but not limited to, communities with minority populations, communities with low-income populations, or both. A total of eight hearings were held between June 1 and June 22, 2010, with hearings held in Pittsfield, Worcester, Lowell, Lakeville, Springfield, Falmouth, and Boston. Written comments were accepted through July 15, 2010.
- MassDEP determined the statewide GHG emissions level in calendar year 1990 and projected the emissions level in calendar year 2020 if no measures are imposed to lower emissions other than those formally adopted and implemented as of January 1, 2009. This "Business as Usual" (BAU) analysis indicated that GHG emissions in Massachusetts have been generally stable since 1990 and will remain relatively stable through 2020;
- The report *Initial Estimates of Emissions Reductions from Existing Policies Related to Reducing Greenhouse Gas Emissions* estimated that policies and programs instituted since January 2007 should result in approximately an 18 percent reduction in GHG below 1990 levels by 2020;
- The report *Cost-Effective Greenhouse Gas Mitigation in Massachusetts: An Analysis of*

2020 Potential indicated that the technical potential of additional cost-effective policies and programs could result in GHG emission reductions of up to 35 percent below 1990 levels by 2020;

- Based on analysis presented in the *Massachusetts Clean Energy and Climate Plan for 2020*, the portfolio of measures examined could reduce GHG emissions 18 percent to 33 percent below 1990 levels by 2020. This range captures uncertainties in future economic trends, energy markets, and implementation of proposed policies.

Determination of 2020 Limit

In determining the GHG emissions limit for 2020, I am aware that actions taken under other statutory mandates, such as the Green Communities Act of 2008, and established state policies to promote energy conservation and cleaner energy sources are expected to produce GHG reductions of 18 percent below 1990 levels by 2020. Therefore, the question before me is where in the remaining statutory range of 18 percent to 25 percent reduction it is practical and appropriate to set the 2020 limit. Central to that question is what additional actions of policy, regulation, and legislation could be pursued that would achieve additional emissions reduction by 2020 and beyond. As I indicated in the *Draft Climate Implementation Plan* issued April 30, 2010, I have considered a wide range of measures but included in the *Massachusetts Clean Energy and Climate Plan for 2020* only those additional measures that provide significant energy cost savings or create clean energy jobs, and I use the sum total of GHG reductions that would be achieved by those cost saving and job producing measures as guidance for setting the 2020 limit.

I received many public comments urging me to set the 2020 limit at or above 25 percent, as well as a smaller number of comments suggesting going no further than 19 or 20 percent. I note that, in setting the limit, I am constrained by the statutory range of 10 to 25 percent below 1990 levels for 2020. I am also mindful of the statutory mandate of 80 percent reduction by 2050, which leads me to reach as high as is practical in setting the initial limit for 2020.

I also take note of the many constructive comments I received on possible measures to achieve the 2020 limit and, indeed, go beyond it in reducing GHG emissions. While I cannot respond to each comment individually, rest assured that all of these comments were carefully considered in the development of the policies incorporated in the Massachusetts Clean Energy and Climate Plan for 2020.

Based on the findings above and with full consideration of the public comments received, I hereby determine that a responsible and achievable GHG emissions reduction limit for 2020 that maximizes opportunities to realize energy cost savings, increase energy independence, and promote growth in clean energy jobs in Massachusetts is 25 percent and that the aggregate of the portfolio of measures, discounting for uncertainty and potential implementation constraints, outlined in the *Massachusetts Clean Energy and Climate Plan for 2020* is sufficient for the Commonwealth to achieve the 2020 reduction limit of 25 percent. I also find that a limit of 25 percent will not have an undue economic impact but rather provide opportunities for energy cost savings and spur economic growth, even as it moves the Commonwealth towards the ultimate statutory mandate of 80 percent reduction by 2050.

Conclusion

Pursuant to the findings and determination made above, I have met my obligations under Chapter 21N to establish a GHG emissions limit between 10 percent and 25 percent below 1990 levels for the year 2020 by January 1, 2011. This limit, which I have set at 25 percent, together with the portfolio of GHG mitigation measures presented in the *Massachusetts Clean Energy and Climate Plan for 2020*, is a substantial step forward in the Commonwealth's ongoing efforts to grow our clean energy economy, reduce energy costs, become more energy independent and minimize climate change impacts to the citizens, environmental resources, and economy of Massachusetts.

December 29, 2010
Date

Ian A. Bowles

B-8

DEVAL L. PATRICK
GOVERNOR

TIMOTHY P. MURRAY
LIEUTENANT GOVERNOR

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT
STATE HOUSE • BOSTON 02133
(617) 725-4000

2007 APR 18 PM 2:49

By His Excellency

DEVAL L. PATRICK
GOVERNOR

EXECUTIVE ORDER NO. 484

LEADING BY EXAMPLE—CLEAN ENERGY AND EFFICIENT BUILDINGS

WHEREAS, buildings are significant users of energy, water and natural resources, consuming 39% of U.S. energy, 70% of U.S electricity, 12% of U.S. potable water, and 40% of raw materials globally;

WHEREAS, the Commonwealth of Massachusetts manages over 64 million square feet of buildings at hundreds of facilities, which annually consume over 1 billion kilowatt hours of electricity, 22 million gallons of heating oil, and 46 million therms of natural gas;

WHEREAS, such energy consumption results in greenhouse gas emissions totaling more than 1.1 million tons per year, equivalent to the emissions generated by more than 200,000 cars driven for one year;

WHEREAS, environmental and health issues related to energy consumption, such as global climate change, regional mercury contamination, and urban asthma rates are critical issues that need to be addressed immediately and comprehensively;

WHEREAS, state government has an obligation to lead by example and demonstrate that large entities such as state colleges and universities, prisons, hospitals and others can make significant progress in reducing their environmental impacts, thereby providing a model for businesses and private citizens;

WHEREAS, by setting clean energy targets and developing clean energy practices, state agencies can play an important role in the development and support of new and local technologies, fostering innovation and benefiting the Massachusetts economy;

WHEREAS, leading-by-example programs can not only reduce environmental and health impacts but can also lead to significant cost savings;

WHEREAS, the Commonwealth is already committed to environmental protection and resource conservation through a variety of regional and state commitments, including, but not limited to, the Clean State Initiative, the Massachusetts Beyond 2000 Solid Waste Master Plan, the New England Governors/Eastern Canadian Premiers 2001 Climate Change Action Plan, the Commonwealth's Climate Protection Plan, the Toxics Use Reduction Reform Act of 2006, the Massachusetts Zero Mercury Strategy, and the Mass. LEED Plus green building standards for state construction;

WHEREAS, all the clean energy and environmental efforts under way within state government operations should be coordinated to ensure that programs are developed and implemented as effectively and efficiently as possible;

WHEREAS, this Administration intends to send a clear message to all state agencies that practicing what we preach is a priority and that agencies should integrate clean energy, environmental protection, and resource conservation programs, policies and procedures into all appropriate aspects of governing;

NOW, THEREFORE, I, Deval L. Patrick, Governor of the Commonwealth of Massachusetts, by virtue of the authority vested in me by the Constitution, Part 2, c. 2, § I, Art. I, order as follows:

I affirm that state agencies shall prioritize practices and programs that address resource use at state facilities, including a reduction in energy

consumption derived from fossil fuels and emissions associated with such consumption.

Furthermore, I direct the Executive Offices of Energy and Environmental Affairs (EOEEA) and Administration and Finance (A&F) to establish and direct a **Leading by Example Program** (the Program), the purpose of which shall be to oversee and coordinate efforts at state agencies, including all UMass campuses and all state and community colleges, to reduce their environmental impact. Such efforts shall include, but not be limited to, the provisions of this Order to promote energy conservation and clean energy practices, as well as waste reduction and recycling, environmentally preferable procurement, toxics use reduction, water conservation, sustainable transportation, open space and natural resource protection, and improved compliance practices.

The Secretaries of EOEEA and A&F or their designees shall co-chair the **Leading by Example Council** (Council), which shall consist of members from each of the Commonwealth Executive Offices, with specific additional membership to be determined by the co-chairs. The purposes of the Council shall be to provide advice and feedback to the Program to facilitate the implementation of key initiatives that will result in reduced environmental impacts at state agencies. The Council shall coordinate efforts with all agencies, who shall appoint program coordinators to act as liaisons between the Council and agency staff and support Program efforts.

Furthermore, the Program shall direct all efforts across state government to track and measure progress toward clean energy and environmental goals, develop long-term programs at state facilities to identify and implement cost-effective initiatives that will result in environmental improvement, and offer educational and training efforts necessary to carry out the provisions of this Order and other related directives. Agencies shall provide all necessary support to the Council and Program and agency staff shall serve, as appropriate, on the Council or other internal committees as requested by the Secretaries of EOEEA and A&F. Agencies shall also provide all requested data related to facility operations and energy use at least annually or on an alternative schedule determined by the Council.

I. Energy Targets for Agency Buildings

All Commonwealth agencies as a whole and, to the greatest extent feasible individually, shall meet the following targets:

1. Reduce greenhouse gas emissions that result from state government operations by 25% by Fiscal Year 2012, 40% by 2020 and 80% by 2050. In calculating emissions, agencies shall use Fiscal Year 2002 as the baseline, and emissions reductions shall be measured on an absolute basis and not adjusted for facility expansion, load growth, or weather.

2. Reduce overall energy consumption at state owned and leased (at which the state pays directly for energy) buildings by 20% by Fiscal Year 2012 and 35% by 2020. Such reductions shall be based on a Fiscal Year 2004 baseline and measured on a BTU per square foot basis.

3. Procure 15% of agency annual electricity consumption from renewable sources by 2012 and 30% by 2020. This mandate may be achieved through procurement of renewable energy supply, purchase of renewable energy certificates (RECs) in accordance with EOEEA guidance and/or through the production of on-site renewable power. Only renewable sources that qualify for the Massachusetts Renewable Portfolio Standard (RPS) shall be eligible. Alternative compliance payments under 225 CMR 14.08 shall not be required under this Order.

4. Utilize bio heat products with a minimum blend of 3% bio based materials for all heating applications that use #2 fuel starting with the winter of 2007-2008, and 10% bio heat blend by 2012.

5. All new construction and major renovations, effective immediately, must meet the Mass. LEED Plus green building standard established by the Commonwealth of Massachusetts Sustainable Design Roundtable.

6. Reduce potable water use, as compared to 2006, by 10% by 2012 and 15% by 2020.

Where appropriate, EOEEA, A&F and the Council shall establish alternative baselines and guidelines for meeting the above targets.

II. Clean Energy Committee

A Clean Energy Committee, to be chaired by Secretary of the Executive Office of Energy and Environmental Affairs and the Commissioner of the Division of Capital Asset Management (DCAM), or their designees, shall be established to facilitate implementation of this Order and to assist agencies in their efforts to meet the targets and requirements herein. The Committee shall consist of representatives of the Division of Energy Resources (DOER), the Operational Services Division (OSD), and other agencies as determined by the chairs. The Committee shall meet regularly and shall communicate with agencies through designated Program Coordinators, who shall be responsible for disseminating all applicable information from the Committee to agency staff, coordinating agency energy activities, and tracking and reporting all requested energy consumption data to the Committee and Council.

The Committee shall, by February 1st of each year, submit to the Governor an annual report on the results of energy conservation actions taken by agencies during the prior fiscal year, the environmental and economic impacts of such actions, and recommendations for future energy reductions. The Committee shall also solicit advice on energy reduction goals from experts outside of state government, including, but not limited to, federal agencies, other states, and not-for-profit organizations. The Committee shall also consider and propose longer-term energy conservation strategies for state government and submit such proposals to the Governor.

III. Energy Measures and Strategies

To meet the above targets, agencies may utilize a variety of energy conservation, energy efficiency and renewable energy strategies, including but not limited to:

- Comprehensive on-site energy efficiency programs
- Installation of energy efficient HVAC equipment
- Fuel switching
- Purchase of energy efficient products

- Increased energy conservation by employees
- Installation of on-site renewable energy and combined heat and power systems
- Procurement of renewable energy
- Use of bio-based and other alternative fuels
- Purchase of Renewable Energy Certificates

To meet the goals of this Order, all agencies shall adopt, where applicable, specific measures including but not limited to:

Energy Conservation

- Develop and disseminate an agency-wide policy that encourages employees to reduce energy use by turning off lights in rooms when not in use, shutting down computers when leaving work, minimizing use of personal appliances, and other actions that will lead to a reduction in energy consumption and costs.
- Run dishwashers and laundry equipment only when fully loaded.
- Set thermostats 2 degrees lower than usual during the winter and 2 degrees higher than usual during the summer.
- Reduce lighting in common areas without compromising safety.
- Minimize energy use at facilities during non-work hours.

Energy Efficient Products

I direct the Environmentally Preferable Products (EPP) Program of OSD to continue to make energy efficient products available on statewide contracts that meet the needs of state agencies and the requirements of this Order. Agencies shall also adopt, where applicable, specific energy efficiency measures including but not limited to the following:

- Use only efficient lights such as compact fluorescent lamps, LED lighting, or other similar products. Until further notice, agencies shall be prohibited from purchasing incandescent lights unless absolutely necessary to meet a specific and unique agency need.
- Install LED and/or photoluminescent exit signs to replace those with incandescent or fluorescent lighting wherever cost effective.
- Install programmable thermostats.

- Install motion sensors or timing devices in rooms that are used only intermittently, such as conference rooms, bathrooms, etc.
- Procure only computers, monitors, copiers, printers, and other office equipment that are EnergyStar qualified, enable all EnergyStar features upon installation, and establish policies and procedures to ensure that such equipment continues to operate efficiently during its life.

Energy Efficiency Programs

I direct the Division of Capital Asset Management, in collaboration with EOEEA, to maximize the number and scope of energy efficiency efforts at state facilities. DCAM and EOEEA shall, in consultation with A&F, identify and recommend appropriate changes to construction laws and financing mechanisms necessary to ensure that the following goals are achieved by the end of Fiscal Year 2012:

- Comprehensive, large-scale energy efficiency projects at all appropriate facilities over 100,000 square feet.
- Implementation of energy efficiency programs such as installation of new equipment, agency coordinated performance contracts, and lighting retrofits at all facilities where the cost of such programs is less than $1 million.
- Completion of smaller energy efficiency projects at all appropriate smaller state facilities where the cost of such projects is less than $100,000, and electric and gas utility incentive programs cover a significant portion of the project cost.

Furthermore, DCAM and EOEEA shall coordinate efforts to ensure that:

- All renovation and new construction projects identify and utilize all available utility rebates.
- All applicable buildings over 50,000 square feet undergo a "retro-commissioning" process to identify and implement low-cost and no-cost energy and water conservation measures with short payback periods.
- Changes to building processes, funding mechanisms and regulations that are necessary to meet the goals of this Order are developed and implemented.

In addition, DCAM is directed to ensure that site selection for leased space considers energy performance.

Energy Training and Maintenance

DCAM's Office of Facilities Maintenance shall, in coordination with agencies:

- Develop and implement a facility maintenance program and schedule for lighting and HVAC systems, including but not limited to, lubricating, balancing, aligning, vacuuming, cleaning, and checking seals, to ensure optimum efficiency.
- Ensure that all appropriate staff receive regular training on proper facility management and maintenance practices.

IV. Renewable Energy

To achieve the renewable energy goals of this Order and obtain 15% of agency electricity from renewable resources by 2012 and 30% by 2020, agencies shall make every effort to power their facilities with clean, renewable energy resources (e.g. wind, solar PV, solar thermal, biomass, landfill gas, anaerobic digestion) that are RPS eligible. Such efforts may include the installation of on-site distributed generation, the purchase of renewable power from energy suppliers, and/or the use of Renewable Energy Certificates (RECs) in compliance with the REC guidance established by EOEEA.

EOEEA, DCAM, OSD and DOER shall continue to assist agencies in meeting these goals through bundled clean electricity contracts, technical and financial assistance, project management and policy initiatives. These entities shall continue to monitor and evaluate options for increasing the renewable energy portfolio of state government's electricity use.

V. Biofuels

To achieve the 3% bioheat goal of this Order, agencies shall commence the purchase of this fuel as of October 1, 2007 for all facilities that use #2 heating oil, or as soon as available through statewide contracts. To facilitate agency use of this fuel, EOEEA and OSD shall conduct informational and training sessions prior to October 1, 2007 to address any

questions and report on the result of the bioheat pilot conducted during the winter of 2006-2007. Additionally, OSD is hereby directed to establish a heating fuel contract that specifies biofuel for oil heating products specified by this Order.

Furthermore, I direct EOEEA and OSD to work with cities and towns to inform them of this new policy and encourage them to utilize bioheat. Pending availability, performance and cost, EOEEA and OSD shall review annually the use of bioheat and develop recommendations for increasing the bioheat goals in this Order to a minimum of 10% by 2012.

VI. Building Design and Construction

DCAM and all agencies involved in the construction and renovation of state facilities shall ensure that all new construction and major renovation projects are energy and water efficient, conserve the use of resources, and provide healthy and productive spaces for employees, clients, and visitors.

To achieve these goals, I endorse the recommendations of the Commonwealth of Massachusetts Sustainable Design Roundtable (Roundtable), which require all new construction at state agencies and significant renovation projects over 20,000 square feet to meet a Mass. LEED Plus building standard. For projects smaller than 20,000 square feet, all projects shall at least meet the minimum energy performance standards established by the Roundtable.

The Mass. LEED Plus standard includes:

- Certification by the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) program for all new construction and major renovation projects over 20,000 square feet;
- Energy Performance 20% better than the Massachusetts Energy Code;
- Independent 3rd party commissioning;
- Reduction of outdoor water consumption by 50% and indoor water consumption by 20% relative to standard baseline projections; and
- Conformance with at least 1 of 4 identified smart growth criteria.

The Mass. LEED Plus standard shall apply to all projects overseen by DCAM and any other executive agency, as well as those that are built for use by state agencies on state land. In addition, EOEEA shall coordinate efforts to incorporate the Mass. LEED Plus standard into all non-executive branch agencies involved in construction. EOEEA and DCAM shall report each year on progress made with regard to integration of this standard into state building projects.

Furthermore, whenever DCAM requires the construction of a new building to be leased by DCAM, DCAM shall establish and incorporate energy performance criteria consistent with the energy goals of this Order.

Additionally, I direct EOEEA and DCAM to support education and training programs for agency personnel and periodically consult with design and construction practitioners to review progress in meeting green building standards, develop strategies to improve communication of the benefits of green buildings, and identify new opportunities for expanded green building efforts.

VII. Distributed Generation

In order to facilitate the installation of on-site renewable energy and Combined Heat and Power projects, within 6 months of the date of this Order, the DOER shall provide an analysis of the barriers to distributed generation that impede the successful completion of such projects at state facilities and, through collaboration with DCAM, OSD, and the Comptroller's office, shall develop recommendations on addressing identified barriers.

VIII. Forward Capacity Market

In order to take advantage of the new ISO-New England Forward Capacity Market (FCM) Program, including the Demand Response Program, which allocate payments for new electric generation capacity, and measurable reductions in electricity use, agencies shall identify and submit all applicable projects for inclusion in the FCM program. DCAM shall coordinate this effort and, in collaboration with EOEEA and OSD, establish the necessary vehicles to facilitate agency participation in this program as well as ensure that payments received are allocated to agencies for additional energy reduction activities. DCAM may elect to

allocate portions of FCM payments in order to manage this program as well as other related energy efforts.

IX. Energy Tracking

The EOEEA is hereby charged with development and implementation of an Energy Information System (EIS) that shall facilitate the tracking of agency energy use and prioritization of energy efficiency programs and projects at state facilities. Such a system will allow facilities to compare building energy consumption and rate energy performance of Commonwealth buildings. DOER and DCAM shall collaborate in the development of the EIS and shall work to ensure that DCAM information systems, such as CAMIS, are effectively linked with any new energy tracking systems. EOEEA and DCAM shall annually track all energy use at state facilities to determine compliance with the goals of this Order and, as appropriate, share this data with other state agencies to further the purposes of this Order.

The development of the EIS shall not eliminate the need for agencies to track other energy and water use and submit annual data to EOEEA as directed by the Council.

X. Water Conservation

Agencies shall make every effort to reduce overall water use and increase water use efficiency to the maximum extent possible. Toward this end, all state agencies shall reduce water use through the following indoor and outdoor measures:

Indoor Water Consumption

- Conduct periodic water audits and system-wide leak detection programs.
- Work toward metering all significant water uses.
- Strictly apply plumbing codes, and actively promote waterless plumbing fixtures, where appropriate.
- Replace and retrofit older water consuming equipment, such as toilets, faucets and showerheads, with modern, more efficient devices as quickly as possible.

- Implementation of energy efficiency programs such as installation of new equipment, agency coordinated performance contracts, and lighting retrofits at all facilities where the cost of such programs is less than $1 million.

Outdoor Water Consumption

- Minimize, and wherever possible eliminate, use of potable water and groundwater for outdoor watering purposes, street cleaning, and building washing.
- Lower watering frequency.
- Improve watering efficiency by watering lawns and plants only when necessary through use of moisture sensors and/or drip irrigation techniques.
- Incorporate Low Impact Development (LID) techniques wherever possible, including use of natural landscaping, permeable pavement, and native and drought resistant vegetation to prevent run-off and ensure rainwater infiltration into the groundwater.
- When procuring services for lawn and landscape maintenance, require contractors to minimize water use wherever possible through incorporation of the above techniques.

XI. Technology

Agencies are hereby directed to analyze and consider use of innovative technologies wherever possible, either on a pilot- or long-term basis, when such technologies can demonstrate environmental and fiscal benefits. Where possible, and to the extent permitted by law, agencies shall work to identify technologies developed and/or manufactured in Massachusetts.

XII. Financing

In order to facilitate the above efforts, EOEEA and A&F shall, within 6 months of the effective date of this Order, submit to me recommendations concerning financing options that will result in energy and water improvements at state facilities without requiring significant infusion of state funding.

XIII. Resources and Commitment

All agencies shall provide the necessary resources and commitment to meet the goals of this Order.

XIV. Effective Date

This Order shall take effect immediately and shall continue in effect until amended, superseded, or revoked by subsequent Executive Order. This Order shall supersede Executive Order No. 438 and all provisions contained in Administration Bulletin #11 and #12.

Given at the Executive Chamber in Boston this 18th day of April in the year of our Lord two thousand and seven, and of the Independence of the United States of America two hundred and thirty-one.

DEVAL L. PATRICK, GOVERNOR
Commonwealth of Massachusetts

William Francis Galvin
Secretary of the Commonwealth

GOD SAVE THE COMMONWEALTH OF MASSACHUSETTS

Massachusetts

Climate Change Adaptation Report

September 2011

Submitted by the
Executive Office of Energy and Environmental Affairs
and the
Adaptation Advisory Committee

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

DEVAL L. PATRICK
GOVERNOR
TIMOTHY P. MURRAY
LIEUTENANT GOVERNOR
RICHARD K. SULLIVAN, JR.
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1018
http://www.mass.gov/envir

Dear Fellow Massachusetts Citizens,

I am pleased to present to you the first Climate Change Adaptation Report for Massachusetts. The product of many months of research, discussion and analysis by a broad array of practitioners, scientists, non-governmental organizations, and federal, state and local governments, this report fulfills an important mandate of the Global Warming Solutions Act of 2008.

Developed by the Climate Change Adaptation Advisory Committee, the report provides a framework for assessing a suite of strategic, long-term solutions designed to enable our neighborhoods and natural resources to adapt to climate change at the same time that we strive to mitigate the greenhouse gas emissions that are contributing to it. Indeed, this report makes clear that climate change mitigation and adaptation are two sides of the same coin. While we do our part in reducing and stabilizing greenhouse gas emissions in our state, we must also think seriously about how Massachusetts as a state will be impacted by climate change and how to prepare for and respond to it.

The Climate Change Adaptation Report describes the process, principles, findings, and recommendations of the Advisory Committee, and presents a first step toward the identification, development, and implementation of strategies to advance Massachusetts' ability to better adapt to a changing climate. Like other coastal states, Massachusetts is faced with increasing sea level rise and storm surges, higher temperatures, and changes in precipitation over the course of this century – all of which could contribute to profound impacts on our coastal infrastructure and businesses, public health, and natural ecosystems in coming years.

Using this report as a solid jumping off point, my staff and our agencies will begin evaluating potential strategies contained in the report and work with stakeholders to prioritize them and assess feasibility of implementation. In addition, we plan to form a stakeholder group that will explore mechanisms for addressing the potential impacts of climate change (such as sea level rise) as part of EEA's Massachusetts Environmental Policy Act (MEPA) review process.

In closing, I would like to acknowledge the significant undertaking that this report represents, and extend the Administration's gratitude to Committee members and all those who participated in the various subcommittee discussions that informed this report for their time and valued input.

Regards,

Richard K. Sullivan, Jr.
Secretary

Climate Change Adaptation Advisory Committee

Taber Allison	Massachusetts Audubon Society
Donald Anderson	Woods Hole Oceanographic Institution
Eugene Benson	Alternatives for Community and Environment
Roseann Bongiovanni	Chelsea Greenspace and Recreation Committee
Donald Boyce	Massachusetts Emergency Management Agency (MEMA)
Andrew Cavanagh	University of Massachusetts–Amherst
Marc Draisen	Metropolitan Area Planning Council
Paul Epstein	Harvard Medical School
Brian Fairbank	Jiminy Peak Mountain Resort and EOS Ventures
David Foster	Harvard Forest
Hector Galbraith	Manomet Center for Conservation Sciences
Timothy Griffin	Tufts University
Raymond Jack	Massachusetts Water Works Association
Nathaniel Karns	Berkshire Regional Planning Commission
Paul Kirshen	Batelle Memorial Institute
Wayne Klockner	The Nature Conservancy
Arthur Marin	Northeast States Center for a Clean Air Future
Bernie McHugh	Massachusetts Land Trust Coalition
William Moomaw	The Fletcher School, Tufts University
Al Niederfringer	Travelers Companies, Inc.
Paul Niedzwiecki	Cape Cod Commission
Wendy Northcross	Cape Cod Chamber of Commerce
Angela O'Connor	New England Power Generators Association, Inc.
Karen O'Reilly	Lexington Insurance Group
John Ramsey	Applied Coastal Research and Engineering
Jeff Reade	AECOM
Bud Ris	New England Aquarium
Erika Spanger-Siegfried	Union of Concerned Scientists
Carl Spector	City of Boston
Melissa Stults	ICLEI–Local Governments for Sustainability
Alexander Taft	National Grid
Peter Weiskel	U.S. Geological Survey
Norman Willard	U.S. Environmental Protection Agency
Robert Zimmerman	Charles River Watershed Association

Chair:

David Cash	Executive Office of Energy and Environmental Affairs

State Agencies Steering Committee:

Kathleen Baskin	Executive Office of Energy and Environmental Affairs
Brian Brodeur	Department of Environmental Protection
Jack Buckley	Department of Fish and Game
Bruce Carlisle	Office of Coastal Zone Management
Michael Celona	Department of Public Health
John Clarkeson	Executive Office of Energy and Environmental Affairs
Lee Dillard Adams	Department of Environmental Protection
Douglas Fine	Department of Environmental Protection
Christian Jacqz	Executive Office of Energy and Environmental Affairs
Ronald Killian	Department of Transportation
Edward Kunce	Department of Environmental Protection
Ann Lowery	Department of Environmental Protection
Vandana Rao	Executive Office of Energy and Environmental Affairs

Other Contributors and Reviewers:

Melanie Fitzpatrick	Union of Concerned Scientists
Alicia McDevitt	Executive Office of Energy and Environmental Affairs
Purvi Patel	Executive Office of Energy and Environmental Affairs
Holly Johnson	Executive Office of Energy and Environmental Affairs
Linda Benevides	Executive Office of Energy and Environmental Affairs
Robert Keough	Executive Office of Energy and Environmental Affairs
Lisa Capone	Executive Office of Energy and Environmental Affairs
Catherine Williams	Executive Office of Energy and Environmental Affairs
Kurt Gaertner	Executive Office of Energy and Environmental Affairs

Project Manager:

Kathleen Baskin	Executive Office of Energy and Environmental Affairs

Editor:

Vandana Rao	Executive Office of Energy and Environmental Affairs

Design and Layout:

Jane Pfister	Executive Office of Energy and Environmental Affairs

Interns:

Craig Altemose, Celine Clabault, Rebecca Gallagher, Noah Hodgetts, Kira Sargent, Seth Sheldon, Cassandra Snow, Bruce Strong, Victoria Wolff, Audrey Lamb

Acknowledgements

The Executive Office of Energy and Environmental Affairs (EEA) would like to extend its gratitude to members of the Climate Change Adaptation Advisory Committee for providing their time, expertise, and vision to create this report.

This effort was able to draw on input from a large cross-section of stakeholders. We would also like to thank members of the public who provided input at various meetings and during the informational sessions held during the spring of 2009.

A special thanks to all the subcommittee chairs— Andrew Finton, Jack Buckley, Ronald Killian, Edward Kunce, Michael Celona, Ann Lowery, John Clarkeson, and Bruce Carlisle—for facilitating and gathering input from subcommittee members and coordinating meetings. We are grateful to members of each of the subcommittees who invested time and effort to provide subject-matter expertise to supplement existing data resources in each sector, assess resource vulnerabilities, and develop potential strategies to adapt to climate change.

We would also like to acknowledge Bruce Carlisle and Julia Knisel from the Office of Coastal Zone Management for their work on Part I of the report; to Ron Killian from the Massachusetts Department of Transportation (MassDOT) for his detailed reviews of drafts, and; to John O'Leary from the Department of Fish and Game (DFG) for his technical input and reviews of various chapters.

The report greatly benefited from the work of all our interns who helped with meetings, and supported various subcommittees.

Finally, EEA's team that managed the Advisory Committee process, Kathleen Baskin, Vandana Rao, and John Clarkeson and Jane Pfister, who designed this report, deserve special recognition.

Authorizing Statute

Global Warming Solutions Act of 2008

SECTION 9. Notwithstanding any general or special law to the contrary, the secretary shall convene an advisory committee to analyze strategies for adapting to the predicted impacts of climate change in the commonwealth. The advisory committee shall be chaired by the secretary, or his designee, and comprised of representatives with expertise in the following areas: transportation and built infrastructure; commercial, industrial and manufacturing activities; low income consumers; energy generation and distribution; land conservation; water supply and quality; recreation; ecosystems dynamics; coastal zone and oceans; rivers and wetlands; and local government.

Table of Contents

Executive Summary

Climate change is the greatest environmental challenge of this generation, with potentially profound effects on the economy, public health, water resources, infrastructure, coastal resources, energy demand, natural features, and recreation. The Commonwealth of Massachusetts is committed to doing its part to mitigate and adapt to this challenge, recognizing the necessity of engaging in adaptation planning today by taking a close look at strategies that could help the state become more resilient and ready to adapt to climate change as it occurs.

The Global Warming Solutions Act, passed by the Massachusetts Legislature and signed by Governor Deval Patrick in 2008, directed the Secretary of Energy and Environmental Affairs (EEA) to convene an advisory committee to develop a report, analyzing strategies for adapting to the predicted changes in climate. This report by the Massachusetts Climate Change Adaptation Advisory Committee is organized into two parts. Part I includes an overview of the observed and predicted changes to Massachusetts' climate and their anticipated impacts, key findings, a set of guiding principles to follow, and key adaptation strategies that cut across multiple sectors. Part II is organized into five broad areas, describing for each area the vulnerabilities to climate change and outlining adaptation strategies that could help increase resilience and preparedness.

Key Predictions and Impacts

Massachusetts' climate is already changing and will continue to do so over the course of this century—ambient temperature has increased by approximately 1°C (1.8°F) since 1970 and sea surface temperature by 1.3°C (2.3°F) between 1970 and 2002. These warming trends have been associated with other observed changes, including a rise in sea level of 22 centimeters (cms) between 1921 and 2006, more frequent days with temperatures above 32°C (90°F), reduced snowpack, and earlier snow melt and spring peak flows (Frumhoff et al., 2006, 2007; Hayhoe et al., 2006). By the end of the century, under the high emissions scenario of the Intergovernmental Panel on Climate Change (IPCC), Massachusetts is set to experience a 3° to 5°C (5° to 10°F) increase in average ambient temperature, with several more days of extreme heat during the summer months. Days with temperatures greater than 32°C (90°F) are predicted to increase from 5 to 20 days annually that Massachusetts experiences today to between 30 to 60 days annually; while up to 28 days annually are predicted to reach above 38°C (100°F), compared to up to two days annually today (Frumhoff et al., 2006, 2007). Sea surface temperatures are also predicted to increase by 4°C (8°F) (Dutil and Brander, 2003; Frumhoff et al., 2007; Nixon et al., 2004), while winter precipitation—mostly in the form of rain—is expected to increase by 12 to 30 percent. The number of snow events is predicted to decrease from five each

month to one to three each month (Hayhoe et al., 2006).

Massachusetts' vast coastline makes it particularly vulnerable to climate change. Assuming that sea level continues to increase at its current rate, because land in Massachusetts is naturally subsiding, by the end of the century, it is expected to rise by another one foot (IPCC, 2007). In addition, the magnitude of sea level rise is predicted to be compounded by thermal expansion of the oceans, the melting of ice on land (such as Greenland) and the collapse of the West Antarctic Ice Sheet. By the end of this century, under the IPCC high emissions scenario with ice melt, it has been suggested that sea level rise resulting from all these factors could reach six feet (Pfeffer et al., 2008). Since a large percentage of the state's population, development, and infrastructure is located along the coast, the impact of this change will be significant, putting the Massachusetts economy, health, natural resources, and way of life at risk.

Higher temperatures, especially the higher incidence of extreme heat days, will have a negative impact on air quality and human health. In general, impacts from climate change on human health can include respiratory illnesses, exacerbation of allergies and asthma, an increase in vector borne diseases, and degraded water quality. Floods from surges of coastal waters and high intensity precipitation events also threaten the state. If these events occur with greater intensity and frequency, as is predicted by many climate change models, the damage could be more severe and cumulative, straining local and state resources and the ability of government agencies to adequately respond.

The Scale and Scope of the Challenge

The issue of climate change, and in particular climate change adaptation, is multi-sectoral and complex. As it plays out in coming years, it will span geographical scales, with greater impacts predicted in areas along the coast and in floodplains. Climate change will also vary temporally—some of the impacts may not be felt for another 30 years or further in the future, while others are already upon us. It may also come in bursts and manifest itself as extreme weather events, with the frequency of such events predicted to increase over time. Massachusetts may experience large-scale catastrophic events, similar to Hurricane Katrina in New Orleans (2005) and the ice storm in Massachusetts (2008), or may see smaller but incremental changes that could have long-term impacts on freshwater resources, fisheries, food crops, coastal properties, and the economy.

The Costs and Risks Associated with Climate Change

While the costs of making changes and actively managing the built and natural environments to buffer the impacts of climate change may be substantial, the cost of inaction may be far higher. A sea level rise of 0.65 meters (26 inches) in Boston by 2050 could damage assets worth an estimated $463 billion (Lenton et al., 2009). Evacuation costs alone in the Northeast region resulting from sea level rise and storms during a single event could range between $2 billion and $6.5 billion (Ruth et al., 2007).

Common Strategies Across All Sectors

Several themes and climate change adaptation strategies that resonate across multiple sectors became evident during meetings of the Advisory Committee and through the development of this report. These strategies represent broad approaches that can shape and inform many climate change adaptation efforts in Massachusetts.

Some solutions to address climate change adaptation can also be considered mitigation strategies because, in addition to contributing to increased resilience and preparedness to climate change, they concurrently achieve reductions in greenhouse gas emissions that contribute to the problem.

The need to perform risk and vulnerability assessments was widely recognized across all sectors. These assessments determine levels of susceptibility and exposure to and impacts of climate change among people, physical structures and assets, natural resources and the environment, economic conditions, and other resources and interests. Areas needing thorough risk and vulnerability assessments include existing critical infrastructure and facilities, vulnerable natural habitats and ecosystems, vulnerable groups or populations, community- or region-specific hazards and threats, water supplies, businesses, homes and other structures, and social and cultural resources. Strongly connected to these assessments is the need for accurate and robust data, because better data collection leads to more accurate risk assessments and more informed decision-making.

Although the state already has data and information to initiate many of the adaptation strategies outlined in this report, more up-to-date and accurate information, models, and decision-support tools representing future climate change predictions and estimates are necessary. These include increased monitoring and observations of key climate parameters, creation or use of models and climate assessments down-scaled to be Massachusetts-specific, collection and use of high-resolution land elevation topography and near shore seafloor bathymetry, collection of improved and expanded socio-economic, epidemiological and demographic information, and development of key decision-support tools.

Once the risks and vulnerabilities are properly assessed through the use of this information, their impacts must be minimized through effective planning and management. For example, future risks and costs can be reduced for new development and redevelopment through the careful siting and inclusion of design, engineering, construction and maintenance standards that account for higher sea levels, increased temperatures, more intense coastal storms, and inland flooding. Also, sound land use decisions—guided by regulation and standards, incentives, and technical support—will help local communities adapt to and withstand climate change impacts.

Another important set of cross-cutting strategies identified during the development of this report include measures that preserve, protect, and restore natural habitats and the hydrology of watersheds. These strategies not only benefit natural resources and habitat, but can also play a critical role in protecting and increasing resilience of key infrastructure sectors, human health, and the local economy.

Finally, effective emergency response systems will be critical in preparing for climate change impacts and extreme weather events. These will especially be needed at the local level, where the first responses typically originate. Government officials and emergency response crews at all levels should assess and enhance emergency management tools and capabilities such as the State Risk Assessment Inventory, the State Comprehensive Emergency Management Plan, the State Hazard Mitigation Plan, and mapping and information systems in order to respond to climate change.

Regarding infrastructure, the most significant vulnerability of existing structures stems from the fact that they were built based on historic weather patterns, not taking into account future predicted changes to sea level, precipitation, or flooding. This puts the infrastructure at increased risk of future damage and economic costs. Therefore, having more accurate maps and surveys—such as LiDAR (Light Detection and Ranging) elevation surveys—will help update current conditions, identify vulnerable facilities, and improve predictive capability. Incorporating these changes into the repair and upgrade of existing infrastructure, as well as into the improved siting and design of future infrastructure, will help minimize the anticipated impact of climate change effects on the infrastructure network. Key strategies include bolstering infrastructure resources by increased conservation, efficiencies, reuse of resources, and timely maintenance; building system redundancies; updating land use, siting, design, and building standards to include climate change projections; using natural systems for enhanced protection; and increasing resilience of infrastructure and the built environment.

Sector-Specific Strategies

Various adaptation alternatives, opportunities, and measures are available to address vulnerabilities arising from climate change. Strategies vary by type, scale, scope, and institutional responsibility.

An analysis of natural resources and habitat identifies potential strategies to enable the four broad ecosystem types in Massachusetts—forested, aquatic, coastal, and wetland—to adapt to climate change. These include protecting ecosystems of sufficient size and across a range of environmental settings, maintaining large-scale ecosystem processes and preventing isolation, limiting ecosystem stressors, and maintaining ecosystem health and diversity. These also include using nature-based adaptation solutions, embracing adaptive management, and developing a unified vision for conservation of natural resources, which can be carried out on a collaborative basis.

Predicted impacts of climate change on human health include the potential for increased heat stress; increased respiratory and heart diseases; elevated levels of ozone and particulate matter; higher pollen counts; increased vector-borne diseases; more outbreaks of water-borne diseases; and degraded surface water quality and increased shellfish pathogens. Extreme weather events can disrupt power, sanitary and health care services, and access to safe and nutritious food, while damaging homes and property. The public and private healthcare systems can address climate change-related demands by going through a network-wide climate change needs assessment that examines enhancing regionalization efforts to address non-emergency situations, developing and increasing responsive capacity through collaboration and improved coordination, and potentially relocating vulnerable health care facilities. In addition, there is a need to improve capacity to adequately detect and treat against pests and diseases, achieve and maintain ambient air quality standards, increase outreach to and support for vulnerable populations, and improve indoor air quality.

Climate change is also expected to affect many aspects of Massachusetts' economy and all levels of government. Climate change impacts will put greater stress on governments by increasing demand for emergency and other services. Among industries expected to be affected are weather-dependent activities such as agriculture, forestry and fisheries, and other industries such as manufacturing (which includes computers, electronic equipment, fabricated metal, and machinery) and service industries, such as real estate management, tourism and recreation, and health care. Examples of impacts include increased flooding, which can affect all sectors of the economy; less winter precipitation in the form of snow, which could adversely affect recreation; and higher temperatures adversely affecting outdoor workers, agricultural

output, the maple syrup industry, and fisheries populations.

Strategies to prepare and enable these industries to become more resilient to climate change include establishing redundant supply routes and sources; developing local and renewable sources of energy; examining possible changes in insurance markets that better capture future climate-related risks; assessing, and protecting facilities and cultural sites that are particularly vulnerable to flooding and sea level rise; and revising bank finance formulas to reflect risk over the duration of mortgages. Strategies for local, state, and federal governments—such as enhancing essential services, engaging in long-range local and regional planning, and developing guidelines, regulations, and standards—can help society better cope with predicted changes in climate.

Coastal resources, including residential and commercial development, ports, and infrastructure; coastal engineering for shoreline stabilization and flood protection; and coastal, estuarine, and marine habitats, resources, and ecosystem services are especially susceptible to increasing sea level rise, flooding, storm damage, and erosion. The ability to address changes in the coastal environment is reliant upon access to strong planning, management, and collaboration among various public and private entities. By incorporating climate change projections into existing strategic, management, and fiscal plans, resiliency in the face of climate change can be enhanced.

Conclusion

The time to address climate change is now. It is clear that while some climate change adaptation strategies are new, many are simply extensions or modifications of existing programs and efforts to practice good environmental stewardship, protect public health, and preserve public safety. The ability to adapt to climate change will be improved through robust science, data collection and analysis; inclusion of climate change in the criteria and evaluation of programs; application of a climate change lens to current planning efforts; examination of regulations, as needed, to take climate change into account, and; continuation of current efforts to increase resilience and decrease vulnerabilities in a wide variety of public and private assets.

Planning for and managing impacts of climate change before they occur are preferable to reactive decision-making after an impact takes place. This approach has the potential to reduce costs, minimize or prevent impacts to public health and safety, and minimize damage to crucial natural resources and built infrastructure. Both management and planning should be flexible, dynamic, and adaptive, and strategies must be continuously revisited and revised.

REFERENCES

Dutil, J. D., and K. Brander, 2003. Comparing productivity of North Atlantic cod (Gadus morhua) stocks and limits to growth production. Fisheries Oceanography 12: 502-512.

Frumhoff, P. C., J. J. McCarthy, J. M. Melillo, S. C. Moser, and D. J. Wuebbles, 2006. Climate Change in the U.S. Northeast: A report of the Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

Frumhoff, P. C., J. J. McCarthy, J. M. Melillo, S. C. Moser, and D. J. Wuebbles, 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

Hayhoe, K., C. P. Wake, T. G. Huntington, L. Luo, M. D. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. Degaetano, T. J. Troy, and D. Wolfe, 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Climate Dynamics 28:381-407, DOI 10.1007. Online at: www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

IPCC (Intergovernmental Panel on Climate Change), 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Avery, M. Tignor, and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, 996 pp.

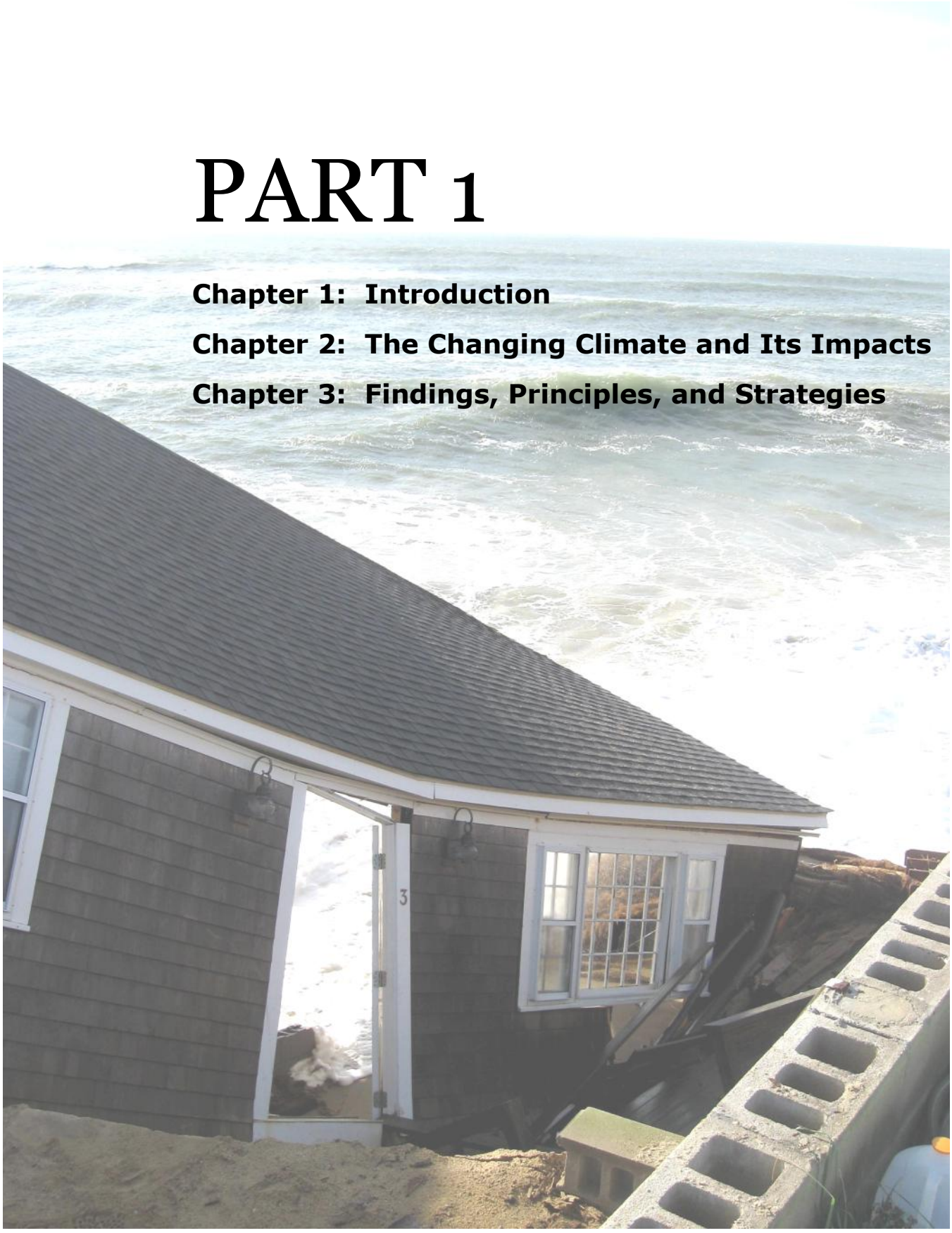
Lenton, T., A. Footitt, and A. Dlugolecki, 2009. Major Tipping Points in the Earth's Climate System and Consequences for the Insurance Sector. World Wide Fund for Nature, Gland, Switzerland and Allianz SE, Munich, Germany. http://knowledge.allianz.com/climate_tipping_points_en.html.

Nixon, S. W., S. Granger, B. A. Buckley, M. Lamont, and B. Rowell, 2004. A one hundred and seventeen year coastal water temperature record from Woods Hole, Massachusetts. Estuaries: 27(3): 397-404.

Pfeffer, W.T., J. T. Harper, and S. O'Neel, 2008. Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise: Science, Vol. 321, No. 5894, pp. 1340-1343.

Ruth, M., D. Coelho, and D. Karetnikov, 2007. The US Economic Impacts of Climate Change and the Costs of Inaction. University of Maryland: Center for Integrative Environmental Research.

PART 1



1 Climate Change Adaptation in Massachusetts

The Commonwealth of Massachusetts is already experiencing the effects of climate change in the form of hotter summers, rising sea levels, more frequent flooding, and warmer waters — leading to a growing concern about how the impacts of these changes will affect the state's future. The "Perfect Storm" of October 1991, which was once considered a one in greater than 1,000-year event, is now a one in 200- to 500-year event (Kirshen at al., 2008). Storms such as the Hurricane of 1938, which caused widespread coastal flooding and resulted in losses such as loss of life, property, and infrastructure, are now considered one in two-year events in Massachusetts. Extensive areas of beachfront are lost to coastal erosion and some groundwater supplies near the coast are rendered undrinkable by saltwater intrusion. Every summer, 5 to 20 days now reach over 32°C (90°F), nearly double of what it was 45 years ago. This results in poor air quality and causes significant respiratory and cardiovascular health problems, especially for children and the elderly.

Over the last 40 years, fish stocks have shifted north to remain within their preferred temperature range (Nye et al., 2009). Summer heat stress reduces Massachusetts dairy milk production by 5 to 10 percent and weed problems escalate for local farmers. River and stream flooding from increased extreme rain events results in combined sewer overflows and the increased stormwater can cause outbreaks of water-borne diseases from pathogens such as Giardia and Cryptosporidium. Migratory songbirds decline as their habitat is reduced and degraded, while stands of hemlock fall prey to the woolly adelgid, an invasive insect.

Over the next several decades, temperatures are expected to continue to increase. As winters get warmer and receive less snow, Massachusetts ski areas and other winter recreation businesses will be adversely affected. By 2100, the Northeast region can expect a decrease of 10 to 20 percent in skiing days, resulting in a loss of $405 million to $810 million per year (Ruth et al., 2007). With warmer marine waters, lobster, cod, and other commercially important seafood species will become harder to find in state waters and nearby fishing grounds.

Other industries are also vulnerable to climate change. By the end of the century, the $31 million maple sugar industry is projected to lose 17 to 39 percent in annual revenue due to decreased sap flow. With increasing temperatures, electricity demand in Massachusetts could increase by 40 percent in 2030, most of which would occur in the summer months and require significant investment in peak load capacity and energy efficiency measures (Ruth et al., 2007). Also this increase in energy demand for cooling triggers the electric grid to fire up fossil-fuel powered "peaking" plants—among the most expensive of the region's energy generation portfolio to operate—resulting in the production of additional climate change-causing greenhouse gas emissions.

Taken as a whole, these impacts can have significant economic consequences to Massachusetts. Studies quantifying climate change impacts on the U.S. Gross Domestic Product (GDP) estimate that, by the year 2100, under a business-as-usual emissions scenario, damages from climate change are projected to cost up to 2.6 percent of the U.S. GDP (Ackerman et al., 2009). There are no studies that have downscaled economic impacts of climate change to the state level, but it seems logical and likely that a coastal state like Massachusetts will see significant impacts to its economy from sea level rise, precipitation shifts, and temperature changes.

At the same time, it is important to recognize that, even with these potential negative economic impacts, climate change may create new economic opportunities. From new fish stocks to longer growing seasons, new natural resource-related opportunities might emerge. With a variety of sectors that develop and deploy technologies to address water quality, sewerage and stormwater, these businesses might be able to take advantage of new markets as precipitation patterns change. With an integrated policy to reduce greenhouse gas emissions, build a clean energy economy, and gain energy independence, Massachusetts has already seized state, national, and global economic opportunities in clean energy research and development, manufacturing, delivery and services.

Recognizing these concerns and the potential opportunities, Massachusetts enacted the Global Warming Solutions Act of 2008. Along with mandating immediate action to reduce

Massachusetts' contribution to global warming, the Act established the Climate Change Adaptation Advisory Committee to investigate the potential impacts of climate change in Massachusetts and propose strategies to adapt to these impacts. This report presents the work and recommendations of the committee. This introductory chapter summarizes the Global Warming Solutions Act, describes the committee and its work, and provides an overview of the remainder of the report.

The Global Warming Solutions Act

In recognition of the scope and magnitude of the threat and opportunities posed by global climate change, Governor Deval Patrick signed the Global Warming Solutions Act on August 13, 2008. Enacted by the state Legislature under the leadership of Senate President Therese Murray, Senate Committee on Global Warming and Climate Change Chairman Marc Pacheco, and House Speaker Salvatore DiMasi, the Act affirms Massachusetts' leadership in clean energy and environmental stewardship by requiring reductions in greenhouse gas emissions from 1990 levels by between 10 and 25 percent by 2020, and by 80 percent by 2050. In December 2010, in compliance with the new law, the Secretary of Energy and Environmental Affairs set the 2020 reduction limit at 25 percent, and unveiled the *Massachusetts Clean Energy and Climate Change Plan for 2020*, which lays out a strategy to achieve that goal.

Among other components, the Global Warming Solutions Act contains a section focused on meeting the threats and challenges posed by climate change. Section 9 of the Act requires the Secretary of Energy and Environmental Affairs (EEA) to convene and chair an advisory committee "to analyze strategies for adapting to the predicted impacts of climate change in the Commonwealth". To ensure expansive and diverse input, the Act called for broad advisory committee membership, with experts from a range of sectors facing climate change impacts. The Act also required the advisory committee to submit to the Legislature a report of its findings and recommendations on strategies for adapting to climate change.

The Climate Change Adaptation Advisory Committee

In June 2009, the EEA Secretary named the Climate Change Adaptation Advisory Committee to advise the State on strategies for adapting to sea level rise, warming temperatures, increased incidence of floods and droughts, and other predicted effects of climate change. As mandated by the Act, the committee includes members representing the following sectors: transportation and built infrastructure; commercial, industrial, and manufacturing activities; low-income consumers; energy generation and distribution; land conservation; water supply and quality; recreation; ecosystem dynamics; coastal zone and ocean; rivers and wetlands; and local government. The committee also included experts in public health, insurance, forestry, agriculture, and public safety.

Five technical subcommittees provided forums for in-depth examination of specific topic areas:

- Natural Resources and Habitat
- Key Infrastructure
- Human Health and Welfare
- Local Economy and Government
- Coastal Zone and Oceans

In addition, a sixth subcommittee, under the local economy and government subcommittee focused on land use issues. The subcommittees comprised of members of the full committee, as well as additional experts and representatives. (See sector chapters for the subcommittee membership list.) In all, more than 200 individual experts, professionals, and stakeholders participated in the advisory committee process.

To develop the report, the committee followed a deliberate process to gain public input, evaluate data and information, develop recommendations, and inform the Legislature.

Public Engagement

To provide wide public input into the report development process, public comment was taken at a series of public information and input sessions. Eight public information sessions were held across the state in June and July of 2009. Presentations at these sessions provided an overview of the Global Warming Solutions Act, a review of current global trends on climate change and predicted climate change impacts in the Northeast (such as temperature change, sea level rise, and precipitation), and examples of how these impacts may affect Massachusetts. After an open forum for public input and questions-and-answers, contact information was solicited to ensure that stakeholders received updates on the committee's progress.

In addition. EEA established a website to publish information about climate change adaptation and

post documents, presentations, references, and advisory committee and subcommittee meeting notices. Every meeting was open to the public and time was specifically allocated at each meeting for members of the public to speak. EEA also publicized the meetings widely via its website, email, newsletters, and The Environmental Monitor, published bi-weekly by EEA's Massachusetts Environmental Policy Act office.

Meetings

The advisory committee met three times between June and October of 2009. At the first meeting, the committee reviewed and discussed predicted climate changes in Massachusetts and approved a general course of action and timeline. The focus of the committee's second meeting was on the progress and general themes emerging from the work of the individual subcommittees and from the public information sessions. Among the common topics identified were shared data and information needs, the preliminary identification of Massachusetts' potential vulnerabilities to climate change impacts, and the recognition of the "cross-cutting" nature of many expected impacts. The six subcommittees met frequently over the summer and fall of 2009, reviewing climate change effects, discerning risks and vulnerabilities, and identifying possible strategies to reduce these threats and ensure that Massachusetts is better positioned to address and adapt to a changing climate. In October 2009, at its third meeting, each subcommittee presented the highlights of its recommendations to the whole committee. These presentations were followed by questions and deliberations, and a discussion on the final steps of the process.

Legislative Briefings

Over a two-month period between October and December of 2009, the advisory committee made presentations on its efforts and progress to the House Committee on Global Warming and Climate Change, chaired by Representative Frank Smizik. These presentations included: briefings on Climate Change Science provided by Rob Thieler of the U.S. Geological Survey and on Coastal Zone and Ocean topics by Bud Ris of the New England Aquarium; briefings on Key Infrastructure by Alexander Taft of National Grid and Ray Jack of the Town of Falmouth; on Local Economy and Government by Karen O'Reilly of AIU Holdings, Inc. and Missy Stults from ICLEI—Local Governments for Sustainability, and on Land Use by Marc Draisen of the Metropolitan Area Planning Council; and briefings on Natural Resources and Habitat by Andrew Finton of The Nature Conservancy and on Human Health and Welfare by Paul Epstein of Harvard University. The briefings were open to the public and well attended.

Overview of the Climate Change Adaptation Advisory Committee Report

This report to the Legislature presents the work and recommendations of the committee in two parts. Part I, which is comprised of three chapters, contains the over-arching conclusions and recommendations of the committee. Chapter 2 presents a summary of the observed and forecasted changes in climate parameters and the known and expected impacts in Massachusetts. Chapter 3 contains several key findings that emerged from the committee process and describes a set of principles that guided the committee process and should serve as guidelines for future development and implementation of climate change adaptation strategies. Chapter 3 also presents cross-cutting strategies, which were informed by and developed directly from the information and ideas generated by the individual sector-specific subcommittees.

Part II contains individual sector-specific chapters. These chapters contain analysis and policy suggestions for specific topics (or "sectors"): Natural Resources and Habitat, Key Infrastructure, Human Health and Welfare, Local Economy and Government, and Coastal Zone and Oceans. Each chapter provides a general overview of the sector and its general vulnerabilities, followed by a description of sub-sectors with specific vulnerabilities and impacts that could result from predicted climate change (as described in Chapter 2), and strategies to help increase resilience, decrease vulnerabilities, and better prepare the sector for a changing climate.

Each strategy is associated with one of two implementation timelines—short-term and long-term. Short-term strategies are those strategies that can be implemented over the next five years—a time frame that is considered to be a typical planning horizon. Long-term strategies are those that may take many years to implement, or would not be expected to be initiated for at least five years, such as larger infrastructure projects or strategies dependent on data collection and monitoring. In addition, no regret strategies are also identified for each sector, i.e., strategies that are easily implemented, help to make systems more resilient, and would offer substantive benefits beyond climate change adaptation.

REFERENCES

Ackerman, F., E. Stanton, C. Hope, and S. Alberth, 2009. Did the Stern Review Underestimate US and Global Climate Damages? Energy Policy 37: 2717-2721.

Kirshen P., C. Watson, E. Douglas, A. Gontz, J. Lee, and Y. Tian, 2008. Coastal flooding in the Northeastern United States due to climate change. Mitig Adapt Strat Glob Change 13:437–451.

Nye, J. A., J. S. Link, J. A. Hare, and W. J. Overholtz, 2009. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Marine Ecology Progress Series 393: 111-129.

Ruth, M., D. Coelho, and D. Karetnikov. 2007. The US Economic Impacts of Climate Change and the Costs of Inaction. University of Maryland: Center for Integrative Environmental Research.

2 The Changing Climate and Its Impacts

It is widely accepted by the scientific community that the increased amount of emissions from anthropogenically generated greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), are contributing to changing climatic conditions. Generation of these gases has increased dramatically in the last century from industrial processes, fossil fuel combustion, and changes in land use (e.g., deforestation). In its 2007 report, the Intergovernmental Panel on Climate Change (IPCC) found that the "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC, 2007).

Global climate change is already causing and will continue to result in significant local impacts.

Since the start of the Industrial Revolution, emissions of greenhouse gases from human activity have resulted in accumulation in the atmosphere, trapping more heat and enhancing the "greenhouse effect". Without the natural heat-trapping function of these gases, the earth's atmosphere would be too cold to support life. CO_2 concentrations, however, are higher today than they have ever been during human history. There is broad agreement and high confidence this increase in greenhouse gas concentrations is changing the earth's climate—not only raising average global temperatures, but more importantly, altering regional and local climatic and weather patterns (IPCC, 2007). Observed effects of climate change include increased atmospheric and ocean temperatures, heat waves, increased evapotranspiration and precipitation, and a greater intensity of storms, floods, and droughts. Thermal expansion of a warmer ocean and the melting of glaciers are contributing to a rise in sea level. These changes are expected to continue for a minimum of several decades even if greenhouse gas emissions are reduced.

This chapter summarizes the observed and forecasted changes in climate conditions and the expected impacts in Massachusetts.

The Global Scale

Globally, CO_2 concentrations have reached 385 parts per million (ppm)—about 105 ppm greater than during pre-industrial times (see Figure 1). The

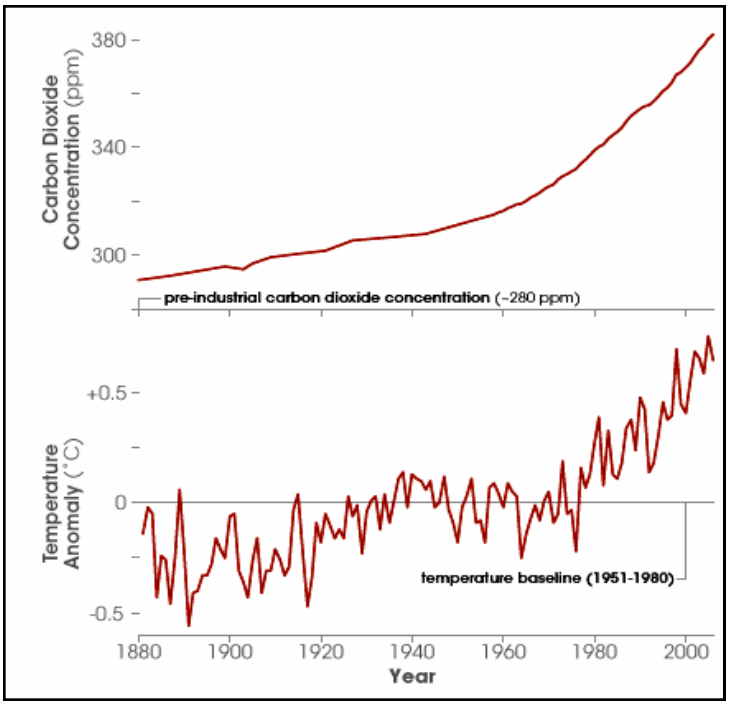


Figure 1: ***Global Temperature and CO_2 Trends***
Source: NASA graphs by Robert Simmon, based on carbon dioxide data (Dr. Pieter Tans, NOAA/ESRL) and temperature data (NASA Goddard Institute for Space Studies).

increasing atmospheric CO_2 and other heat trapping greenhouse gases are causing an increase in the earth's air temperatures. Over the last 100 years, global average temperature has increased by about 0.74°C (1.3°F) (IPCC, 2007). A recent study by NOAA (2010) indicates that the summer of 2010 tied with 1998 as having the warmest global temperature on record. For the period between January–September in 2010, the global combined land and ocean surface temperature was 0.65°C (1.17°F) above the 20th century average of 14.1°C (57.5°F). Also, each year in the 2000s was hotter than average conditions in the 1990s, which, in turn, were hotter than average conditions in the 1980s. This trend could continue until the end of the century. According to climate models, global temperatures could increase by an additional 1.8° to 4°C (3.2° to 7.2°F) by the end of this century.

The ongoing debate in the scientific community is not about whether climate change will occur, but the rate at and extent to which it will occur and the adjustments needed to address its impacts. Much of the uncertainty about the predicted rate and extent

of climate change results from the difficulty of projecting whether and how rapidly greenhouse gas emissions will be stabilized or reduced.

In general, relatively modest changes in temperature are predicted to have major impacts on already stressed coastal ecosystems, thus threatening biodiversity and ecosystem-based economies such as fisheries, tourism, and recreation (NOAA, 2009). The amount of water available on a global scale is projected to increase in the higher latitudes by 10 to 40 percent and decrease in already dry regions by 10 to 30 percent. Scientists predict an increase in precipitation in the form of heavy rain events, as well as vast desertification of the African continent. Sea level is projected to rise and cause increased coastal inundation, and scientists predict many low lying areas around the world—such as the Nile River Delta, the Ganges-Brahmaputra Delta, and small Pacific Ocean islands—will be submerged.

Annual temperatures across the Northeast have warmed about 1°C (almost 2°F) since 1970.

Global warming is also likely to cause melting of the ice caps. The Arctic is expected to experience ice-free summers within a few years. Overall, the biodiversity of plants and animal species is projected to decrease—20 to 30 percent of the assessed plant and animal species in the world face an elevated risk of extinction.

Climate change is projected to impact food production and cause an increase in the number of people affected by malnutrition. There is also predicted to be an elevation in public health concerns given the expectation of a greater incidence and range of vector-borne diseases and longer disease transmission seasons.

Climate Change Predictions and Impacts in Massachusetts

Peer-reviewed scientific projections and existing data and observations were examined and compiled to help define current conditions and the range of predicted climate changes in Massachusetts. This information was used in the development and analysis of strategies to adapt to these predicted changes. Where available, Massachusetts-specific data were used for this report, but, for the most part, assessments and projected impacts developed for the northeast United States were used as a surrogate for impacts in Massachusetts.

To determine how the climate will change, the Climate Change Adaptation Advisory Committee examined current conditions—for this report, defined as the average of observed data over a 30-year period from 1961–1990, and two future time periods: i) a mid-century view which, unless indicated otherwise, is defined as an average of the

Parameter	Current Conditions (1961–1990)	Predicted Range of Change by 2050	Predicted Range of Change by 2100
Annual temperature[1] (°C/°F)	8/46	2 to 3 / 4 to 5	3 to 5/5 to 10**
Winter temperature[1] (°C/°F)	-5/23	1 to 3 / 2 to 5	2 to 5 / 4 to 10**
Summer temperature[1] (°C/°F)	20/68	2 to 3 / 4 to 5	2 to 6 / 4 to 10**
Over 90 °F (32.2 °C) temperature[2] (days/yr)	5 to 20	—	30 to 60
Over 100 °F (37.7° C) temperature[2] (days/yr)	0 to 2	—	3 to 28
Ocean pH[3,4]	7 to 8	—	-0.1 to -0.3*
Annual sea surface temperature (°C/°F)	12/53[5]	2/3 (in 2050)[5]	4/8
Annual precipitation[1]	103 cm/41 in.	5% to 8%	7% to 14%**
Winter precipitation[1]	21 cm/8 in.	6% to 16%	12% to 30%**
Summer precipitation[1]	28 cm/11 in.	-1% to –3%	-1% to 0%**
Streamflow—timing of spring peak flow[1] (number of calendar days following January 1)	85	-5 to -8	-11 to -13**
Droughts lasting 1–3 months[1] (#/30 yrs)	13	5 to 7	3 to 10**
Snow days (number of days/month)[1]	5	-2	-2 to –4**
Length of growing season[1] (days/year)	184	12 to 27	29 to 43

Table 1: ***Changes in Massachusetts' Climate***

Sources: 1-Hayhoe et al., 2006; 2-Frumhoff et al., 2007; 3-IPCC, 2007; 4-MWRA, unpublished; 5-Nixon et al., 2004
Note: All numbers have been rounded to the nearest whole number. Unless otherwise indicated, the predictions for the year listed as 2050 are for the period between 2035–2064. * *Global data;* ***Predictions for period between 2070-2099*

2035–2064 predictions, and ii) an end-of-the-century prediction (2100).

Each of the two future scenarios has a predicted range of change—the lower number is based on the lowest prediction of the low emissions scenario ("B1" scenario with CO_2 concentration of 550 ppm or above) as outlined by the IPCC (Nakicenovic et al., 2000), and the higher number is based on the highest prediction of the higher emissions scenario ("A1FI" scenario with CO_2 concentration of 970 ppm) as outlined by the IPCC (Nakicenovic et al., 2000). Table 1 provides an overview of the observed and expected changes in Massachusetts' climate over a 140-year period.

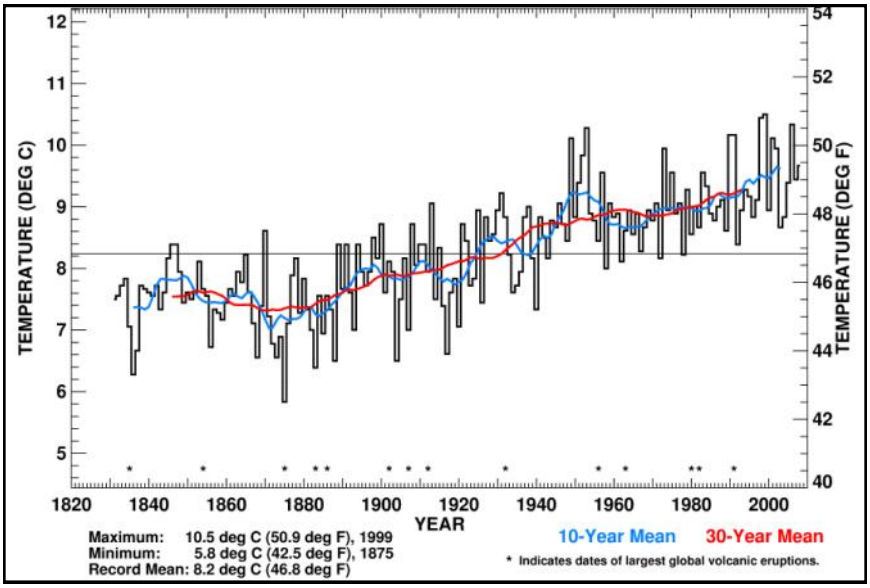


Figure 2: ***Blue Hill Observatory Annual Temperature, 1831–2008***
Source: Michael J. Iacono, Atmospheric and Environmental Research, Inc./Blue Hill Observatory, MA
Note: Plot includes temperature data for 1831–1884 from Milton and Canton that were adjusted to the Blue Hill summit location.

Inherent in scientific predictions of climate change is a measure of uncertainty. Due to the variety of influencing factors, it is difficult to know what the levels of future greenhouse gases emissions will be. The further the projections are made into the future, the higher the level of uncertainty associated with projected emission levels, demographics, economic development, and technological advances that could drive greenhouse gas emissions.

However, the risk to Massachusetts is clear. As a coastal state, Massachusetts is expected to experience significant impacts to its coastline due to sea level rise. All of the scenarios of partial or complete melting of ice caps in Greenland and Antarctica threaten to raise sea level and inundate the highly populated coastal areas of Massachusetts by the end of the century. Scientists also predict that, by mid-century, Massachusetts will experience longer growing seasons, more short-term droughts, and increased precipitation rates especially during the winter months (Hayhoe et al., 2006). The duration of the winter snow season could be reduced by 50 percent, with impacts on industries from skiing to water supplies.

Ambient Temperature

As with global climate change, the climate of the Northeast United States and Massachusetts has already been changing. Over the last century, annual air temperatures from Maine to New Jersey have increased. Weather station records of the United States Historical Climatology Network indicate that the Northeast has been warming at an average rate of nearly 0.26°C (0.5°F) per decade since 1970, and winter temperatures have been rising even faster at a rate of over 0.7°C (1.3°F) per decade (Frumhoff et al., 2006, 2007; Hayhoe et al., 2006). By mid-century, the projected increase is 2.1° to 2.9°C (3.8° to 5.2° F), and 2.9° to 5.3°C (5.2° to 9.5°F) by the end of the century. According to Frumhoff et al (2006), temperatures over the next few decades are projected to increase more in winter than in summer.

Extreme heat in summer is becoming more frequent.

Winters are warming at 0.72°C (1.3°F) per decade since 1970.

These warming trends are associated with other observed changes including, more frequent days with temperatures above 32°C (90°F), rising sea surface temperatures and sea levels, changes in precipitation patterns and amounts, and alterations in hydrological patterns. Heat waves are expected to increase in duration each year as greenhouse gas emissions increase. By late-century, many North-eastern cities can expect 60 or more days per year over 32°C (90°F) under the higher-emissions scenario or at least 30 such days if conservation and renewable energy efforts are successful. (There are now approximately 12 such days each year.) The number of days over 38°C (100°F) in the summer of 2100 could range from 3 to 9 under the lower-emissions scenario to between 14 and 28 under the higher-emissions scenario (Frumhoff et al., 2006, 2007).

Projected increases in temperature could result in a

decline in air quality, aggravate asthma, and cause other human health effects in Massachusetts, which already has one of the highest rates of adult asthma in the United States (Massachusetts Department of Public Health—State Health Facts). Periods of extreme heat—or heat waves—are already significant health threats, especially to children, the elderly, and lower income communities. The extreme heat is most dangerous in urban areas because of a combination of large concentrations of vulnerable populations and a large extent of heat-absorbing pavement and buildings, which cause daytime and nighttime temperatures to be markedly higher than in suburban or rural areas. Heat waves are of particular concern and could have broad implications for public health, infrastructure, government capacities, plants, and crops. The state's susceptibility to these extreme heat events is high, since 36 percent of its land area is urban and more than half of the 100 most populated cities in New England are located in Massachusetts. Higher temperatures can also affect the agricultural section. While a longer growing season due to increased temperatures may support new crops and fruits, agricultural activities could experience compounded impacts due to changes in precipitation and runoff, and increasing weed and pest problems.

Sea Surface Temperature

Data collected at Woods Hole in Massachusetts show that annual mean sea surface temperature increased at a rate of 0.04°C (0.07°F) per year from 1970-2002, a total of 1.3°C (2.3°F) during that period (Nixon et al., 2004). By mid-century, sea surface temperature could increase by 1.7°C (3°F) and, by the end of this century, it could increase 2.2° to 2.8°C (4° to 5°F) under the lower emissions scenario, or 3.3° to 4.4°C (6° to 8°F) under the higher emissions scenario (Dutil and Brander, 2003; Frumhoff et al., 2007; Nixon et al., 2004).

The anticipated effects of sea temperature increases on many coastal and marine animals are not certain , but it is likely that habitat boundaries of some species may shift. Certain native populations will likely move northward toward cooler waters, and the occurrence of species that are typically found in southern latitudes is predicted to increase in Mass-achusetts and nearby waters. While the increased temperatures will have broad effects across estuarine and marine habitats and the ecosystem services they support, impacts to commercially important species will influence the state's fishing industry—both recreational and commercial. For example, cod require habitat with a mean annual bottom temperature below 12°C (54°F). This species will likely disappear from the waters south of Cape Cod by late-century under the higher emissions scenario (Drinkwater, 2005; Dutil and Brander, 2003; Frumhoff et al., 2007). Bottom waters of the Georges Bank fishery, one of the most productive fishing grounds in the eastern Atlantic, may also approach the maximum temperature threshold for cod, reducing recruitment and productivity, and further taxing the sustainability of the region's significant cod fishery (Frumhoff et al., 2007).

In shallower nearshore waters south of Cape Cod, lobster fisheries may be lost by mid-century. Already, declining populations of lobster south of Cape Cod are indicative of possible climate impacts. Increased surface temperatures and more high-latitude freshwater input (from precipitation and ice-melt) may disrupt large-scale circulation patterns in the western North Atlantic, leading to profound cascading effects on marine ecosystems and weather patterns.

Recent scientific literature suggests that climate warming may double the frequency of Category 4 and 5 storms by the end of century, but may decrease the frequency of less severe hurricanes (Bender et al., 2010). Although broad consensus on this issue has not been achieved, several researchers, as part of a World Meteorological Organization panel, recently agreed that there will likely be stronger, but fewer, hurricanes as a result of global warming (Knutson, 2010). Douglas and Fairbanks (2010) suggest that the magnitude of long duration storms, such as a two-day storm, may be increasing. This can have particular impact on the built infrastructure.

Sea Level Rise and Coastal Flooding

Sea-level projections for the 21st century are evolving rapidly. There are several factors that contribute to sea level rise—expansion of the water as its temperature rises, changing water currents, and melting of ice on land (such as Greenland). In Massachusetts, these factors are further amplified by local subsidence of land. Relative sea level rise in Massachusetts from 1921 to 2006 was 2.6 millimeters annually (0.10 inches/year)—an increase of approximately 26 centimeters or 10.2 inches per century (NOAA, 2009) (See Figure 3). Over that same time period, the global rate of sea level rise was about 1.7 mm/year (0.07 inches/year) (IPCC, 2007). Thus, there is about 1 mm/year (0.04 inches/

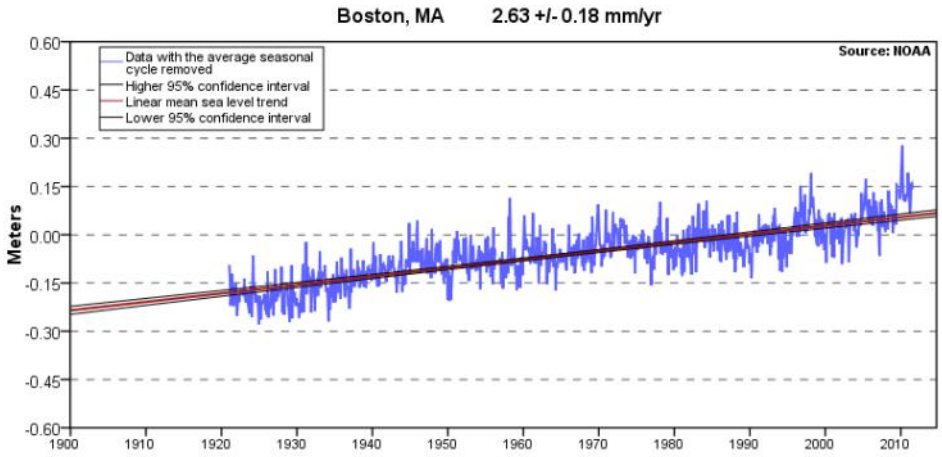


Figure 3: Mean Sea Level Trend measured at the Boston tide gauge.
Source: NOAA. http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8443970

year) local land subsidence in the relative sea level record (Bamber et al., 2009).

The Massachusetts Climate Change Adaptation Advisory Committee relied on three sources of projections for sea level rise by 2100 (Table 2 and Figure 4). First, the 2007 IPCC projections are widely viewed as conservative (Rahmstorf, 2007; Rahmstorf et al., 2007; Jevrejeva, 2008) but are highly credible and internationally recognized. Second, the Rahmstorf et al. (2007) approach uses a relationship between global mean surface temperature and sea level and then projects future changes using the IPCC Third Assessment Report (2001) temperature scenarios. Third, Pfeffer et al. (2008) use the IPCC (2007) steric projection, and add ice melt to it. Pfeffer et al. (2008) base this on physically plausible melt or deterioration rates for Greenland, Antarctica, and other glaciers and ice caps related to different rates of melting and discharge that are known from ice sheet and glacier behavior.

Sea currents also play a role in sea level rise along the Massachusetts coast. The northeastern U.S. may experience additional sea level rise above the global mean due to changes in the strength of the Atlantic Meridional Overturning Circulation, of which the Gulf Stream is a part (Yin et al., 2009; Hu et al., 2009). As the Atlantic Meridional Overturning Circulation slows, the dynamic topography of the sea surface changes and sea-level rises along the coast. Yin et al. (2009) suggest that there is the potential for an additional 15 to 27 cm (5.9 to 10.6 in.) sea level rise in Boston by 2100, while Hu et al. (2009) suggest that a sea level rise of 10 to 30 cm (3.9 to 11.8 in.) will occur in the northeastern U.S. by 2100.

Finally, Bamber et al. (2009) found that the collapse of the West Antarctic Ice Sheet would not only add to sea level rise but, as it shrinks, would also cause a redistribution of ocean mass due to the reduced gravitational attraction of the smaller West Antarctic Ice Sheet. This would be a global effect, most pronounced in a band at ~40° north latitude where the sea level rise is projected to be about 25 percent more than elsewhere around the globe. Coastal Massachusetts extends from roughly 41°10'N to 42° 53'N and would experience the full brunt of this impact. There is presently high uncertainty regarding the potential for full West Antarctic Ice Sheet collapse, but this effect also applies to a partial collapse. Overall, by 2100 sea level rise in Massachusetts could range from 29 to 201 cm.

Current rates of sea level rise and projections for accelerated trends are all significant threats to the coastal communities of the state. Sea level rise would increase the height of storm surges and associated coastal flooding frequencies, permanently inundate low-lying coastal areas, and amplify shore-

Source	Projections by 2050		Projections by 2100		
	Low Emissions	High Emissions	Low Emissions	Mid Emissions	High Emissions
Pfeffer et al 2008	—	—	78/31	83/33	201/79
Rahmstorf 2007	20/8	40/16	50/20	80/32	140/55
IPCC 2007	—	—	18/7	48/19	59/23
Current sea-level trend (A1F1 scenario)	16/6		29/11		

Table 2: *Projected Sea Level Rise (centimeters/inches)*
Note: All numbers have been rounded to the nearest whole number.

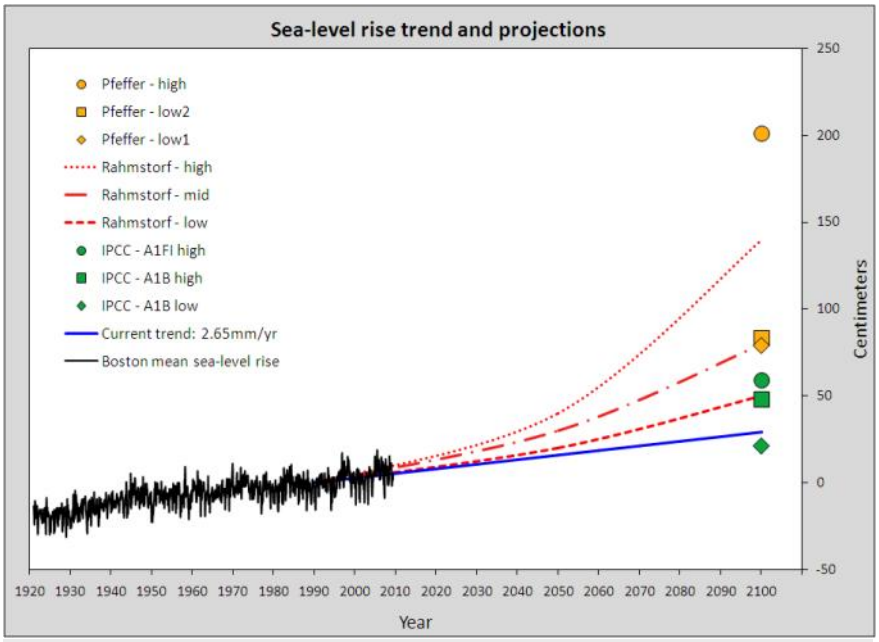


Figure 4: ***Global sea level rise trend and projections***

line erosion. Extensive development and infrastructure, both public and private, would be affected in these expanding vulnerable areas. Analysis of five coastal sites in the Northeast, including Boston and Woods Hole, indicates that future sea level rise would create significant increases in the frequency of today's 100-year flood events (Kirshen et al., 2008).

Increased sea level, combined with increased erosion rates, is also predicted to threaten Massachusetts' barrier beach and dune systems. Development on the beaches themselves, as in the case of Plum Island, will continue to face challenges associated with erosion and storm damage. Barrier beaches will be more susceptible to erosion and overwash, and in some cases breaching. Such breaching will put at risk extensive areas of developed shoreline located behind these barrier spits and islands, such as the shorelines of Plymouth, Duxbury, and Kingston. Engineered structures, such as seawalls designed to stabilize shorelines, could be overtopped. Large areas of critical coastal and estuarine habitat, including the North Shore's Great Marsh—the largest continuous stretch of salt marsh in New England, extending from Cape Ann to New Hampshire—are at risk as they will be unable to adapt and migrate as sea level rises and local land subsides. The National Marine Fisheries Service estimates that 32 percent of the commercial fish and shellfish collected in New England are directly dependent on estuaries and salt marshes for various life stages, including spawning and early stage development (Stedman and Hanson, 1997). Higher sea levels will also intrude on productive aquifers situated in permeable sands and gravels, while drinking water options for more and more communities and private homeowners will become limited due to saltwater intrusion.

Precipitation

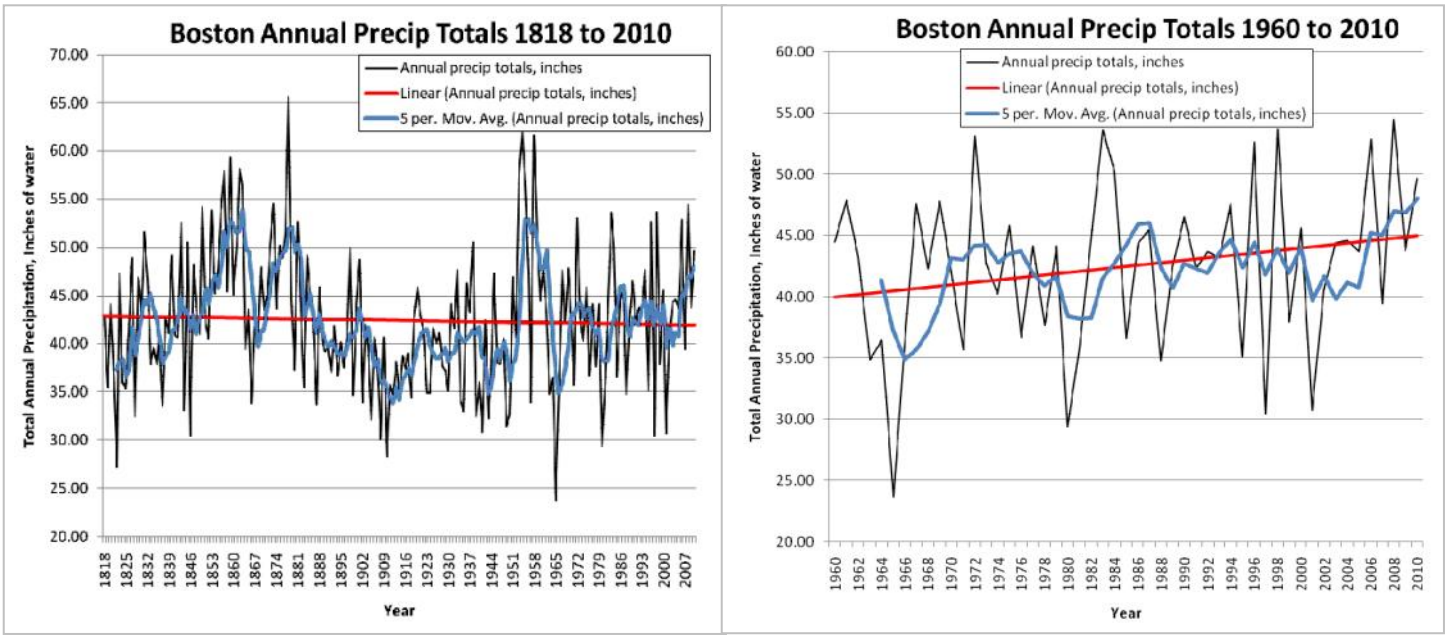
New England is expected to experience changes in the amount, frequency, and timing of precipitation. Although Massachusetts is a water-rich part of the country, the predicted changes could add pressure to the state's water resources. Since 1900, precipitation recorded at United States Historical Climatology Network weather stations across the Northeast has increased on average by 5 to 10 percent.

While precipitation data that goes back nearly 200 years (Figures 5) illustrates a slight decrease in annual precipitation. However, a more recent 50-year view shows an increase in total precipitation by approximately 10 percent (2.12 mm/year). Also, except in the Cape Cod region, the most recent 30-year normal precipitation for Massachusetts is the highest it has been since records started to be taken (Massachusetts Water Resources Commission, 2008). In the past few decades, more of this precipitation has been falling during winter as rain (Frumhoff et al., 2006, 2007; Hayhoe et al., 2006; Keim et al., 2005).There is also evidence of a strong increase in extreme precipitation (defined as the annual maximum daily precipitation depth) since the 1970s (Douglas and Fairbank, 2010) in northern coastal New England.

By the end of the century, under the high-emissions scenario, annual precipitation is expected to increase by 14 percent, with a slight decrease in the summer—a time when river flows are already low—and a 30 percent increase in the winter (Hayhoe et al., 2006). It is predicted that most of the winter precipitation will be in the form of rain rather than snow. This change in precipitation type will have significant effects on the amount of snow cover, winter recreation, spring snow melt and peak stream flows, water supply, aquifer recharge, and water quality. Large areas of the Northeast are projected to lose more than one-quarter and up to one-half of their snow-covered days toward the end of the century in the high-emissions scenario as a result of increased ambient temperature in February and March.

March 2010 was the wettest month on record in Massachusetts with 18.8 inches of precipitation!

Massachusetts is situated in the central part of the



Figures 5: ***Annual precipitation in Boston from January 1818 to December 2010. The blue line represents a five-year moving average and the red line a least squares regression.***

Source: Data from 1818 through 1870 is from the Smithsonian Miscellaneous Collections Volume 79, (reprinted in 1944), Henry Helm Clayton, pages 815-816. Data from 1871 onwards taken from the National Weather Service. Both data sets assembled and arranged by Harlow A. Hyde, DeLand, FL, 2011; graphs provided by the Massachusetts Office of Water Resources at the Massachusetts Department of Conservation and Recreation.

region where thresholds between snow and rain are sensitive and reductions in snow would be the largest (Frumhoff et al., 2006, 2007). Snow is also predicted to fall later in the winter and cease falling earlier in spring. Observed hydrologic changes due to this include the early occurrence of spring "ice-out" on lakes (i.e., the complete thawing of surface ice) by between 9 and 16 days (Frumhoff et al., 2006, 2007; Hodgkins et al., 2002, 2003). These trends are predicted to continue at an increasing rate in future decades, and the impacts caused by these changes are predicted to become more severe (Karl et al., 2009). Furthermore, predictions indicate that the days of peak flow in the spring time—a reflection of the amount of winter snowpack and the timing of melting which currently typically occurs 84.5 days from January 1—will decrease each year by five to eight days by mid-century, and by 11 to 13 days by the end of the century (Hayhoe et al., 2006).

Winter snowpack is decreasing.

The predicted changes in the amount, frequency, and timing of precipitation, and the shift toward more rainy and icy winters would have significant implications. Damaging ice storms similar to the storm in mid-December 2008—which left over a million people in New England without power, caused widespread property and tree damage, and resulted in national emergency declarations in Massachusetts, New Hampshire, and Maine—could increase (IPCC, 2007). As winter temperatures continue to rise and snow cover declines, opportunities for winter recreation such as skiing and snowmobiling will decrease, and the associated billion-dollar industries will suffer. More winter rain is expected to drive more high-flow and flooding events during the winter, earlier peak flows in the spring, and extended low-flow periods in the summer months. These changes in hydrologic cycles would have profound impacts on water resources, including increased flooding and polluted overflows from stormwater and wastewater systems during high periods of flow, and increased stress on surface and ground drinking water sources during periods of drought and low flow. Already today, during dry periods, existing water withdrawals from groundwater aquifers in some parts of the state have caused extensive segments of rivers to go dry and because of the shortage of adequate and uncontaminated water supplies, towns like Brockton, Hull, and Swansea are looking to expensive, energy-intensive desalination solutions. Climate change threatens to exacerbate and replicate situations like these.

Altered timing and amount of streamflow due to reduced snowpack.

Floods

It is forecast that the Northeast will experience a greater frequency of high precipitation events. Past observations show that extreme precipitation events (>50 mm / 2.0 in. of rain) have increased during the period between 1949 and 2002 in eastern Massachusetts (Wake et al., 2006). In 2010, heavy spring rains (three intense rainstorms in March alone) caused flooding throughout the state. A number of rivers were at their highest flows since record keeping began (see Table 3). Scientists predict an 8 percent increase in extreme precipitation events in the northeastern U.S. by mid-century, and up to a 13 percent rise by 2100. Rainfall during the wettest five-day period each year is projected to increase by 10 percent by mid-century and by 20 percent by the end of the century (Frumhoff et al., 2006, 2007).

During the Mothers' Day floods of 2006, communities along the northeastern Massachusetts received 38.1 cm (15 in.) of rain in a 100-hour period.

By 2050, Boston could experience the current 100-year riverine flood every two to three years on average and, by 2100, the current 100-year riverine flood is expected to occur every one to two years under both the low- and high-emissions scenarios. In the case of coastal storms, the frequency and timing of winter storms or nor'easters could change. Under the low-emissions scenario, little change is predicted in the number of nor'easters striking the Northeast, but it could experience approximately 5 to 15 percent more late-winter storms under the high-emissions scenario (Frumhoff et al., 2007).

Streamflow and Drought

Changes in temperature, as well as changes in the amount, timing, and type of precipitation, affect streamflows and drought characteristics. With more winter precipitation in the form of rain and less as snow, there is likely to be more runoff during the winter and less during the spring. This phenomenon along with the increased temperatures would cause streamflow to peak earlier in the year and to be lower in the spring, which is typically when flows are highest. Changes in precipitation and runoff can have a significant impact on fisheries, agriculture, and other natural systems.

Drought is related to soil moisture, which, in turn, is related to evapotranspiration, rainfall, temperature, drainage, and climatic changes. By the end of the century, under the high emissions scenario, the occurrence of droughts lasting one to three months could go up by as much as 75% over existing conditions (Hayhoe et al., 2006). Streamflows would be lower in the summer months, especially under the high emissions scenario, as a result of higher evapotranspiration. Low flows and higher ambient air temperatures would increase water temperatures, which would affect coldwater fisheries, water-dependent industries, growth, habitat, and salmon and other anadromous fish migrations. Observations indicate that the timing of the migration of anadromous fish species, such as the Atlantic salmon and alewives, has advanced in the last few decades and they are migrating earlier in the season (Huntington et al., 2003; Juanes and Beland, 2004).

Station Name	March-April 2010 Peak Flows		Historic Peak Flow		Start of Analysis Period
	Date	Gage Height (m/ft)	Date	Gage Height (m/ft)	
Charles River at Waltham	3/15/2010	2.3 / 7.56	2/3/1976	1.99 / 6.54	1932
Indian Head River at Hanover	3/15/2010	2.23 / 7.32	3/18/1968	2.17 / 7.13	1967
Taunton River near Bridgewater	4/1/2010	4.56 / 14.97	3/20/1968	4.41 / 14.48	1930
Segreganset River near Dighton	3/15/2010	2.64 / 8.66	3/18/1968	2.34 / 7.69	1967

Table 3: ***Recent record High Spring flows in Massachusetts Rivers***
Source: U.S. Geological Survey Massachusetts-Rhode Island Water Science Center
http://pubs.usgs.gov/of/2010/1315/

Toward Adaptation

Changes in the climate can cause both subtle as well as devastating effects to humans, human infrastructure, and natural systems. An increase in temperature can cause increased virulence of viruses, insects and pests; decimation of sensitive crops and plants; increased asthma and other human health effects; and can impact the built environment. Increased intensity of precipitation can cause increased flooding, put humans and their property at risk, ruin crops, and create public health concerns from sewage and hazardous waste leaks. Also, if the timing of the precipitation changes, it could compromise water supplies and water availability for fish and various habitats. Increases in sea level rise can have severe consequences for both natural and manmade systems.

There is a clear and compelling need for actions to advance climate change adaptation in Massachusetts. Scientific consensus affirms that adaptation is necessary despite efforts to reduce greenhouse gas emissions and its impacts. The 2007 IPCC report found that:

Societies across the world have a long record of adapting and reducing their vulnerability to the impacts of weather- and climate-related events such as floods, droughts and storms. Nevertheless, additional adaptation measures will be required at regional and local levels to reduce the adverse impacts of projected climate change and variability, regardless of the scale of mitigation undertaken over the next two to three decades.

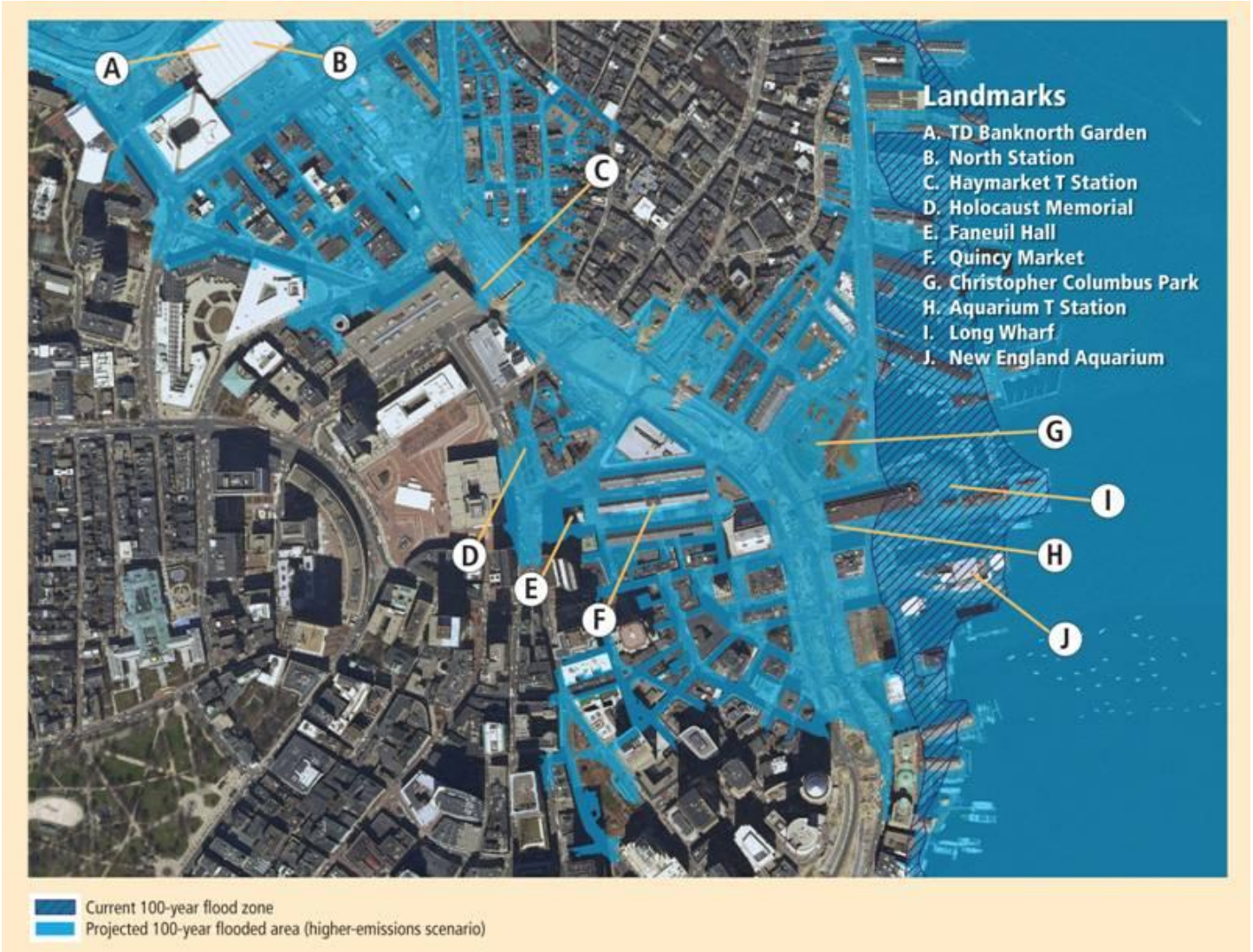


Figure 6: ***Projected Inundation of Boston Landmarks in 100 Year Flood under Higher Emissions Scenario***

Source: Kirshen et al., 2008. Coastal Flooding in the Northeastern United States due to Climate Change

REFERENCES

Bamber, J. L., R. E. M. Riva, B. L. A. Vermeersen, and A. M. LeBrocq, 2009. Reassessment of the Potential Sea-Level Rise from a Collapse of the West Antarctic Ice Sheet: Science, Vol. 324, No. 5929, pp. 901-903.

Bender, M. A., T. R. Knutson, R. E. Tuleya, J. J. Sirutis, G. A. Vecchi, S. T. Garner, and I. M. Held, 2010. Modeled Impact of Anthropogenic Warming on the Frequency of Intense Atlantic Hurricanes. Science. Vol. 327, No. 5964, pp. 454-458.

CCSP, 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. Synthesis and Assessment Product 4.1. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams (Lead Authors)]. U.S. Environmental Protection Agency, Washington D.C., USA, 320 pp. http://www.climatescience.gov/Library/sap/sap4-1/final-report/sap4-1-final-report-all.pdf.

Douglas, E. M., and C. A. Fairbank, July 2011. Is precipitation in northern New England becoming more extreme? A statistical analysis of extreme rainfall in Massachusetts, New Hampshire and Maine and updated estimates of the 100-year storm. Journal of Hydrologic Engineering, 16 (3): 203-217.

Drinkwater, K. F., 2005. The response of Atlantic cod (Gadus morhua) to future climate change. ICES Journal of Marine Science 62: 1327-1337.

Dutil, J. D., and K. Brander, 2003. Comparing productivity of North Atlantic cod (Gadus morhua) stocks and limits to growth production. Fisheries Oceanography 12: 502-512.

Engelhart, S. E., Horton, B. P., Douglas, B. C., Peltier, W. R., and Törnqvist, T. E., 2009. Spatial variability of Late Holocene and 20th Century sea-level rise along the U.S. Atlantic coast: Geology Vol. 37 No. 12 p. 1115-1118.

Frumhoff, P. C., J. J. McCarthy, J. M. Melillo, S. C. Moser, and D. J. Wuebbles, 2006. Climate Change in the U.S. Northeast: A report of the Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

Frumhoff, P. C., J. J. McCarthy, J. M. Melillo, S. C. Moser, and D. J. Wuebbles, 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

Hayhoe, K., C. P. Wake, T. G. Huntington, L. Luo, M. D. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. Degaetano, T. J. Troy, and D. Wolfe, 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Climate Dynamics 28:381-407, DOI 10.1007. Online at: www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

Hodgkins, G. A., I. C. James II, and T. G. Huntington, 2002. Historical changes in lake ice-out dates as indicators of climate change in New England, 1850–2000. International Journal of Climatology 22: 1819–1827.

Hodgkins, G. A., R. W. Dudley, and T. G. Huntington, 2003. Changes in the timing of high river flows in New England over the 20th century. Journal of Hydrology 278: 244–252.

Hu, A., G.A. Meehl, W. Han, and J. Yin, 2009. Transient response of the MOC and climate to potential melting of the Greenland Ice Sheet in the 21st century: Geophys. Res. Lett., Vol. 36.

Huntington, T. G., G. A. Hodgkins, R. W. Dudley, 2003. Historical trend in river ice thickness and coherence in hydroclimatological trends in Maine. Climate Change 61: 217-236.

IPCC (Intergovernmental Panel on Climate Change), 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J. T., Y. Ding, D. J. Griggs, M. Noguer, P. J. Van der Linden, X. Dai, K. Maskell, and C. A. Johnson (eds.)]. Cambridge University Press, Cambridge, UK, and New York, 881 pp.

IPCC (Intergovernmental Panel on Climate Change), 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Avery, M. Tignor, and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, 996 pp.

Jevrejeva, S., J. C. Moore, A. Grinsted, and P. L. Woodworth, 2008. Recent global sea level acceleration started over 200 years ago? Geophys. Res. Lett., Vol. 35.

Juanes F., S. Gephard, K. F. Beland, 2004. Long-term changes in migration timing of adult Atlantic salmon (Salmo salar) at the southern edge of the species distribution. Cdn. J. Fisheries and Aquatic Sciences 61: 2392-2400.

Karl, T. R., J. M. Melillo, and T. C. Peterson, 2009. Global Climate Change Impacts in the United States: A state of knowledge report from the US Global Change Research Program. New York, NY: Cambridge University Press.

Keim, B. D., M. R. Fischer, and A. M. Wilson, 2005. Are there spurious precipitation trends in the United States Climate Division database? Geophysical Research Letters 32:L04702, DOI 10.1029/2004GL021985.

Kirshen et al., 2003. Climate's Long-term Impacts on Metro Boston (CLIMB study). Tufts University.

Kirshen, P., C. Watson, E. Douglas, A. Gontz, J. Lee, and Y. Tian, 2008. Coastal Flooding in the Northeastern United States due to Climate Change. Mitigation and Adaptation Strategies for Global Change 13(5-6): 437-451.

Knutson R. T., J. L. McBride, J. Chan, K. Emanuel, G. Holland, C. Landsea, I. Held, J. P. Kossin, A. K. Srivastava, and M. Sugi, 2010. Tropical cyclones and climate change. Nature Geoscience 3, 157–163.

Massachusetts Department of Public Health. Quick Facts about Asthma in Massachusetts.

Massachusetts Water Resources Authority, unpublished data. Summary of 591 pH measurements taken since June 2004.

Massachusetts Water Resources Commission meeting, February 2008. Update by staff on Precipitation Normals in Massachusetts.

Nakicenovic, N., J. Alcamo, G. Davis, B. de Vries, J. Fenhann, S. Gaffin, K. Gregory, A. Grübler, T. Y. Jung, T. Kram, E. L. L. Rovere, L. Michaelis, S. Mori, T. Morita, W. Pepper, H. Pitcher, L. Price, K. Riahi, A. Roehrl, H. Rogner, A. Sankovski, M. Schlesinger, P. Shukla, S. Smith, R. Swart, S. V. Rooijen, N. Victor, and Z. Dadi, 2000. IPCC Special Report on Emissions Scenarios. Cambridge, UK and New York, NY: Cambridge University Press.

Nixon, S. W., S. Granger, B. A. Buckley, M. Lamont, and B. Rowell, 2004. A one hundred and seventeen year coastal water temperature record from Woods Hole, Massachusetts. Estuaries: 27(3): 397-404.

National Oceanic and Atmospheric Administration, 2009: http://co-ops.nos.noaa.gov/sltrends/sltrends.shtml.

National Oceanic and Atmospheric Administration, 2010. State of the Climate Global Analysis. http://www.ncdc.noaa.gov/sotc/?report=global.

Pew Center on Global Climate Change http://www.pewclimate.org/.

Pfeffer, W.T., J. T. Harper, and S. O'Neel, 2008. Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise: Science, Vol. 321, No. 5894, pp. 1340-1343.

Rahmstorf, S., 2007. A Semi-Empirical Approach to Projecting Future Sea-Level Rise: Science, Vol. 315, No. 5810, pp. 368-370.

Rahmstorf, S., A. Cazenave, J. A. Church, J. E. Hansen, R. F. Keeling, D. E. Parker, and R. C. J. Somerville, 2007. Recent Climate Observations Compared to Projections: Science, Vol. 316, No. 5825, pp. 709.

State Health Facts. http://www.statehealthfacts.org/comparemaptable.jsp?cat=2&ind=87.

Stedman, S. and J. Hanson. 1997. Wetlands, Fisheries and Economics in the New England Coastal States. Habitat Connections. National Oceanic and Atmospheric Administration, National Marine Fisheries.

Wake, C., L. Burakowski, G. Lines, K. McKenzie, and T. Huntington, 2006. Cross border indicators of climate change over the past century: Northeastern United States and Canadian Maritime Region. The climate change task force of the Gulf of Maine Council on the Marine Environment in cooperation with Environment Canada and Clean Air-Cool Planet. www.gulfofmaine.org/council/publications.

World Health Organization, 2007 factsheet. http://www.who.int/mediacentre/factsheets/fs266/en/index.html.

Yin, J., M. E. Schlesinger, R. J. and Stouffer, 2009. Model projections of rapid sea-level rise on the northeast coast of the United States: Nature Geoscience, Vol. 2, No. 4, pp. 262-266.

3 Findings, Principles and Strategies

Recognizing the risks posed by climate change, the Commonwealth of Massachusetts has and will continue to identify and implement measures to protect its social, economic, cultural, and natural resources. There is broad consensus that, even with ambitious global reduction of greenhouse gas emissions, some level of climate change is inevitable (IPCC, 2007). Therefore, in addition to providing strong leadership and action on mitigation, it is important for Massachusetts to continue a similar commitment on climate change adaptation.

The formation of the Climate Change Adaptation Advisory Committee by the Global Warming Solutions Act served as an important impetus and a forum for informed and broad-based dialogue on this issue. Based on the Committee's work, this chapter presents: (1) several key findings that articulate the central themes and challenges of adaptation in Massachusetts; (2) a set of principles that have guided and should continue to guide Massachusetts' approach to adapting to climate change; and (3) a series of common strategies that cut across several, if not all, sectors.

1. FINDINGS

The following findings—based on the common themes, challenges, opportunities, and needs identified through the Committee process—inform all strategies, including the cross-cutting strategies presented later in this chapter, and can continue to shape future climate change adaptation efforts in Massachusetts.

Climate Change Is Already Happening and Will Continue

Climate change is already having demonstrable effects in Massachusetts and the region. As described in Chapter 2, the Northeast has been warming at a rate of nearly 0.27°C (0.5 °F) per decade, and winter temperatures are rising at an even faster rate of 0.72°C (1.3°F) per decade (Frumhoff et al., 2007). These long-term warming trends are associated with other observed changes, including rising sea-surface temperatures and sea levels, more frequent days with temperatures above 32°C (90°F), reduced snowpack, and earlier spring snowmelt resulting in earlier peak streamflows.

While projected climate trends indicate that the situation will worsen, the range in scope and magnitude of these changes, as well as the impacts that they will cause, will be influenced by current and future levels of greenhouse gas emissions. Even with aggressive policies to reduce greenhouse gas emissions, however, efforts will be required to adapt to climate change impacts already in play due to past emissions.

Climate Change Impacts Are Wide Ranging and Affect Many Sectors of Society

From greater frequency of excessively hot days to increased flooding and habitat disruption, the impacts of climate change have broad implications. As an example, predicted sea level rise and the associated increases in flooding, erosion, and salt water intrusion into freshwater aquifers will have adverse effects on residential and commercial development, infrastructure and critical facilities, and natural resources and ecosystems. These impacts, in turn, will affect residents, landowners, private business, industry, government, and many others. Developing effective and efficient responses to climate change will require high levels of communication, coordination, collaboration, and integration across and within all levels of government, in close connection with private businesses and industries, non-governmental organizations, academic institutions, and stakeholder groups.

The Cost of Impacts Will Be High

Impacts from climate change will be very costly. Under the high emission scenario described by the Intergovernmental Panel on Climate Change (IPCC, 2007), the average annual cost of climate change impacts to the U.S. could reach 2.6 percent of the gross domestic product by 2100 (Ackerman et al., 2009). Lenton et al. (2009) estimate that a global sea level rise of 20 inches (0.5 meters) by 2050 would expose $25 trillion to $28 trillion in assets to a 100-year storm event in 136 port megacities worldwide—over $7 trillion in assets in 17 port cities in the United States alone. Boston ranks fourth among U.S. cities with the greatest predicted risk of asset exposure due to sea level rise, with predicted asset exposure from a mid-century 100-year storm event estimated to exceed $400 billion and current asset exposure to a 100-year storm estimated at $77 billion (Lenton et al., 2009). Adding to that, evacuation costs alone from sea level rise and storms in Massachusetts may range between

$2 billion and $6.5 billion, depending on the severity of the storm event (Ruth et al., 2007).

Responding to these impacts with solutions such as large-scale engineering would require significant capital investments, which would be costly to residents, businesses, and governments alike. Difficult decisions and trade-offs will potentially need to be made, therefore, about abandonment, relocation, and fortification of the state's natural and manmade systems. The construction of seawalls, which is one way to counter the effects of sea level rise (Lenton, 2009), could cost $5 to $21 million per linear mile (Union of Concerned Scientists, 2009)—and would come at the cost of other important natural processes. A physical barrier such as a sea wall can deprive beaches of necessary sediment that flows in with the tide, and many recreational beaches can be lost. Other structural solutions would also be expensive. For example, elevating a single family home by two feet could cost $22 to $62 per square foot (Union of Concerned Scientists, 2009) depending on a building's foundation type (Jones et al., 2006). Another option—managed retreat (allowing the coastline to move inland in specified locations as a response to sea level rise)—would affect property values as land and structures are subsumed by the rising sea.

The 1938 Category 3 hurricane that hit the Northeast raised high tide by 10 feet above normal, washed over most barrier beaches in the Narragansett and Buzzards Bays, killed over 600 people, and damaged property worth about $400 million in New York, Connecticut, Massachusetts and Vermont (Ashton et al., 2006). It was estimated that the same hurricane in 1998 would cost $20 billion in insured property damage. (Pielke and Landsea, 1998).

Climate change will continue to impact the future price, affordability, and availability of insurance coverage (Dailey et al., 2009). In many areas of Massachusetts—especially Cape Cod and the Southeast—home and business owners are already facing significant rate increases or denial of coverage as private insurance companies reassess their risk (and reinsurance rates) in the face of an increase in extreme weather events (causing greater risk of wind damage) and the effects of climate change (Breslau, 2007).

Given the uncertainty of future climate conditions and impacts, and the costs associated with certain alternatives to address these impacts, some strategies (or components thereof) are not presently practical or economical. Added to this scenario is the recognition that, over time, the cost of inaction may be even higher and more disastrous than the cost of implementing appropriate adaptation strategies. There is broad consensus that some viable adaptation options for certain sectors would result in lower costs or have low cost-benefit ratios and achieve significant cost savings if implemented sooner rather than later.

Even under current conditions, climate impacts are costly. Flooding of the Boston subway system in 1996 cost over $92 million in damages (Ruth et al., 2007).

Current and Accurate Information Improves Decision-Making

Effective planning and management at the regional and local levels is enhanced by current and accurate information. Although there is enough information to begin implementing many of the strategies outlined in this report, information gaps limit more focused assessments and decision-making. Also, while sector-specific information is necessary, there are certain types of data—such as the acquisition of high-resolution topography as generated by LiDAR (see Strategy #2 under cross-cutting strategies for description) technology—that could support multiple sectors concurrently. Compiling and synthesizing existing information and conducting region-specific analysis will help support the development of more specific strategies to adapt to climate change impacts. Through improvements in the science and methods of "downscaling" global climate models—and by expanding mapping, monitoring, and assessing specific parameters and ecosystem processes—more robust and precise information can be advanced to support the development of strategies targeted to changing conditions in both the built environment and natural resource areas.

Integrating Mitigation and Adaptation Strategies Provides Double Benefits

According to the IPCC (2007), "there is high confidence that neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change". Massachusetts is actively striving to reduce greenhouse gas emissions and address adaptation because of its particular vulnerabilities to climate change. Massachusetts can set an example to others and do its part to minimize the degree to which climate change adaptation will be necessary in the future. Some climate adaptation strategies or responses to reduce risk and vulnerability also serve to reduce greenhouse gas emissions (and vice versa). Identifying these areas of mutual benefit was a core theme throughout the development of this report. There are also areas of potential conflict between

climate change adaptation and mitigation strategies that must be reconciled. As an example, an increase in ambient air temperature can lead to an increase in the use of air conditioning to provide relief during high heat days. This in turn increases the demand for electricity, which in Massachusetts is mainly generated through the burning of natural gas and coal.

Adaptive Management and Forward-Thinking Goals Should Be Built into Current Actions

The science of climate change is constantly improving, as predictions are refined with new data, research, and modeling. Addressing the challenges posed by a changing climate can seem daunting. Incorporating climate change into existing strategic, management, and fiscal plans and building upon existing efforts can, however, readily increase adaptation capacity. The concept of "adaptive management" is particularly suited to climate change response, where planning and decisions are made within a context of incomplete and imperfect knowledge. Adaptive management seeks to reduce risk and uncertainty over time through the deliberate development of iterative and flexible approaches. It relies on monitoring and evaluation to adjust these approaches based on what has been learned.

Long-term choices about climate responses can be segmented into shorter-term, more manageable steps and decisions. By ranking and prioritizing, leveraging resources and shared goals, and enhancing communication, collaboration, and partnerships, forward-thinking climate change responses can be built into current land-use and resource management plans, financial budgets and capital investments, regulatory processes, and similar implementation mechanisms.

Actions Addressing Climate Change May Present Opportunities

The need to adapt to climate change and mitigate the emissions of greenhouse gases could create economic opportunities in Massachusetts. These could include the expansion of sectors such as clean energy, restoration and management services, the construction industry, research and development in an array of high tech sectors, and development of drought- and pest-resistant crops.

2. PRINCIPLES

Each adaptation strategy will have specific elements and considerations. However, the development and implementation of climate change adaptation strategies should be guided by the following core principles.

Broad-Based Participation

The effects of climate change will be felt throughout Massachusetts. To address these challenges effectively, engagement of a wide array of stakeholders is necessary. The development of this report was informed by the active participation of more than 200 experts, representatives, and stakeholders, as well as input from the general public. As efforts to increase Massachusetts' capacity to adapt to climate change advance, diverse and broad participation will continue to be essential.

Best Available Science & Technology

Significant progress has occurred over the past decades in the scientific understanding of the earth's changing climate, its causes, and its impacts. The science and models that inform the understanding of global and regional climate change issues are evolving rapidly. Recognizing the value of this work, the options and strategies being considered in Massachusetts to adapt to climate change impacts should be grounded in the most current and established science and technology.

Strong Leadership

In order to prioritize and implement adaptation strategies, strong leadership will be necessary at the local, state, and federal levels. A national leader on clean energy, climate and environmental issues, Massachusetts is poised to be a pacesetter on climate change adaptation.

Coordination of Efforts

Climate change impacts occur across a range of issue areas. Consequently, developing effective and efficient responses will require strong coordinated efforts among various entities with different mandates and interests— from the private sector, to the state and federal agencies, cities and towns, non-government organizations, and academic institutions. In moving forward, current partnerships should be fostered and new ones developed.

Assisting Vulnerable Populations

Vulnerable populations are broadly defined as those who are more susceptible to the effects of climate change, and for whom adaptive change will be more difficult. Whether by virtue of economic status, social capacity and resources, health, age, or geography, adaptation efforts should be mindful of, and include, planning to meet the unique needs and conditions of people who are most vulnerable, protecting them during sudden extreme events, and helping them adapt to health issues, energy costs, and other chronic impacts.

Cost-Effective and Risk-Based Approaches

With the potential for large impacts from climate change, the current and future benefits and costs of various adaptation alternatives deserve careful consideration. There is explicit recognition that, given the uncertainty of future climate conditions, costs of impacts, and the costs associated with alternative responses, there may be particular strategies (or components thereof) that are not presently practical or economical. Investments of resources need to be made strategically, focusing on: climate-related impacts and their relative risks, timing of occurrence, and uncertainties as well as costs and cost-effectiveness of responses. Priority should be given to strategies that have clear, robust, and long-term benefits and significance, including those that,

- address known risks and vulnerabilities;
- support large portions of the public over special interests;
- promote public health, safety, security, and well-being;
- protect particularly vulnerable populations or those with unequal access to resources;
- build upon current programs and successes;
- protect critical habitats and key ecosystem services; and
- provide economic growth potential.

3. CROSS-CUTTING STRATEGIES

The technical subcommittees of the Climate Change Adaptation Advisory Committee—which were organized by general issue areas or "sectors"—made significant progress in their review of climate change impacts, general risks and vulnerabilities, and possible strategies. As is evidenced by the wide-ranging assembly of strategies for each sector in Part II of this report, there are numerous options and prospective pathways for improving capacity in Massachusetts to adapt to climate change. The following set of recommended strategies was informed by and developed directly from the information and ideas contained in the individual sector-specific chapters. These cross-cutting strategies emerged as common themes in several, if not all, sectors and were discussed extensively at the subcommittee and the advisory committee meetings. Guided by the principles and informed by the findings presented earlier in this chapter, these strategies represent a synthesis to direct and inform climate change adaptation efforts in Massachusetts.

Strategy #1 — Combine Mitigation and Adaptation Strategies

The committee discussed the connection between the state working to reduce its share of greenhouse gas emissions as part of a global effort, and the influence that will have on reductions in climate change impacts. The Committee found many strategies that would have the dual benefit of helping a sector adapt to a changing climate while also helping to reduce or mitigate greenhouse gas emissions. One such strategy is the acquisition or conservation of large forest blocks that would minimize stressors, and provide ecosystem resilience, while also serving as a carbon sink.

Another strategy is deploying measures such as the implementation of Smart Growth, including "low impact development" (LID) and Leadership in Energy and Environmental Design (LEED) building methods. LID and LEED techniques reduce the environmental and energy footprint of conventional residential and commercial buildings and provide for better site-design. With less energy, water resource, and material demands for both construction and operation, harmful emissions can be reduced. These strategies will reduce operation and maintenance costs over time, while conserving natural habitats, providing for better localized water recharge, and minimizing anthropogenic stress on ecosystems. Other examples of specific strategies that address both climate change adaptation and mitigation are reductions in allergens and asthmogens from decreased emissions, using tree plantings to reduce heat island effect and reduce heating and cooling costs, and increasing adaptive building techniques, such as white roofs, to reduce cooling requirements (and therefore emissions).

Strategy #2 — Identify and Fill Critical Information Gaps

Effective adaptation efforts require up-to-date and accurate information, models, and decision-support tools. Addressing the key knowledge and technological gaps to identify and predict vulnerability of both the built environment and natural resource areas is a high priority. Much of the information and products currently used for land-use and infrastructure planning, lending and investment decisions, and resource management reflect climate conditions from the last several decades and do not accurately reflect current risks of inundation, temperature change, and other climate-related impacts. Therefore, assessing future risk and developing strategies for adaptation poses significant challenges. Through improvements in the science and methods of "downscaling" global climate models

so that they reflect Massachusetts-specific conditions—and by expanding mapping, monitoring, and assessments of specific parameters and ecosystem processes—more robust and specific information can be advanced to support the development of strategies targeted to changing conditions.

The use of monitoring and modeling—including expansion, acceleration, and leveraging of existing efforts—is essential in following climate trends and simulating climate change scenarios. Other types of monitoring and models will be needed to address vulnerabilities of inland and coastal wetland resource areas; cultural, archaeological, and historic resources at risk; important infrastructure; and water quality and quantity. For all kinds of monitoring, it is important to have consistent methods, frequent sampling and long study durations since many climate-related phenomena are inherently variable and more data points over longer periods will provide a higher degree of confidence in discerning the effects of climate change. Consideration should also be given to providing a single entity or clearinghouse to better support, integrate, standardize, and disseminate these resources within each sector, or across multiple sectors.

A common strategy among all sectors was to collect or update information to better predict impacts from storm-related flooding and sea level rise, such as:

- LiDAR (Light Detection and Ranging) — LiDAR is an airborne laser sensor technology for collecting extremely accurate elevation data. It can be used to help predict the impact of flooding and sea level rise on estuarine marshes and to identify neighborhoods, businesses, and infrastructure at risk from coastal storms and sea level rise.

- Floodplain mapping — Maps of areas that have a 1 percent chance of flooding during a given year (i.e., the 100-year flood) should be updated. Massachusetts' regional equations used for estimating floods of various frequencies, which are derived from available U.S. Geological Survey streamgage data and basin characteristics, have not been updated in over 35 years and do not reflect current conditions (rainfall patterns and impervious surfaces)—much less what would likely occur given future climate change. These shortcomings are illustrated by the fact that many flood damaged areas lie outside the mapped areas at risk of a 100-year flood. In fact, according to the Federal Emergency Management Agency (FEMA), as many as 30 percent of flood damage claims lie outside these areas. It is recommended that various funding sources be pursued vigorously and more flexible and relevant formats for floodplain mapping be discussed with FEMA. Updating the flood maps to reflect current conditions is a first step toward developing maps that can also incorporate predictions of future conditions.
- Rainfall Intensity — It is recommended that the "design storms" (i.e., what qualifies as a 100-year storm or a 50-year storm) for Massachusetts be updated to reflect current conditions and those precipitation conditions predicted for the future. Transportation and environmental agencies and many local planning boards rely on the precipitation return frequencies derived by the National Weather Service in 1961, 1964, and 1977. Precipitation return frequencies are used in designing stormwater controls to attenuate the peak rate of runoff from land development and in sizing culverts. Local culverts are likely undersized, which can potentially cause culvert failure and damage due to flooding. This could get worse over time as rainfall intensity increases with climate change.

Strategy #3 — Advance Risk and Vulnerability Assessments

Risk and vulnerability assessments are used to determine the susceptibility and exposure of groups or communities of people, physical structures and assets, natural resources and the environment, economic conditions, and other resources and interests to changing climate conditions and associated impacts. These assessments can be conducted for various purposes, at different scales, for a range of subjects, and with a range of techniques. While the areas of interest and approaches may vary, these assessments all share the primary goal of quantifying and qualifying levels of risk and vulnerability.

This report provides an initial outline of some of the risks and vulnerabilities for general sectors. These overviews of vulnerability are useful starting points, but in some cases, more complete and detailed assessments are required to generate the necessary materials, information, and tools to support the development, prioritization, and implementation of targeted and robust—yet flexible—climate change adaptation plans and strategies.

Risk and vulnerability assessments can be conducted within the context of the uncertainties and complexities posed by climate change, and through the employment of scenarios, assignment of probabilities, and ranking of impacts. The utility of these assessment outputs, however, is greatly influenced by the quality and accuracy of the information available to drive the analysis. This recommendation is thus closely tied to the previous one. By identifying and filling critical information gaps, the process and products of risk and vulnerability assessments will be enhanced, and lead to better and more cost-effective adaptation plans, actions, and decisions.

Given limited available resources, undertaking a systematic, comprehensive risk and vulnerability assessment for each component of every sector examined in the report is not practical. Consequently, strategic choices must be made to determine the vulnerability assessments to be conducted. As derived from the sector chapters, thorough risk and vulnerability assessments are needed for the following:

- Existing critical infrastructure, including energy generation, transmission, and distribution; communication networks; drinking and wastewater facilities; roads and highways; railways and subways; shipping, transportation, and cruise terminals; ferry and water transportation terminals and facilities; dams, levees, flood barriers, jetties, and breakwaters; and health care facilities
- Economic sectors, including agriculture and aquaculture, fishing, health care and life sciences, technology, financial services, manufacturing, education, government, and tourism
- Vulnerable groups or populations, including economically disadvantaged communities; densely-populated areas (i.e., urban areas); the elderly, infirmed, and young; and non-English speaking or English-as-second language groups
- Natural habitats and ecosystems, including forested, freshwater aquatic, coastal, and marine ecosystems
- Community-specific analyses, including local hazards and threats; critical local facilities; local public and private water supplies; businesses; homes and the built environment; cultural and historical sites; and crucial local natural resources

Strategy #4 — Evaluate and Prioritize Adaptation Strategies for Implementation

Challenging decisions lie ahead regarding the options and alternatives for reducing risk to public infrastructure, private property, and human safety and welfare as a result of climate change. As evidenced from the collection of strategies identified in the individual sector chapters, a broad range of adaptation alternatives, opportunities, and measures exist for the vulnerabilities considered. The strategies vary by type, including monitoring and assessments, policies and regulations, and technical assistance and education; scale, including region, state, community, and neighborhood; scope, including specific economic sectors, elements of the built environment, various aspects of public health and safety, and ecosystem components and processes; and responsibilities, including government agencies, private business and industry, non-government organizations, academic institutions, and individual homeowners.

Given this array of options, there is a strong need to prioritize specific adaptation responses determined to be the most effective and efficient. Evaluation and prioritization of adaptation alternatives should consider many factors including, but not limited to, the probability and magnitude of potential impacts, the vulnerability of the groups or individuals affected, the range and feasibility of alternatives available, broad-based stakeholder input, and the opportunity to build upon current programs and successes. Careful consideration is warranted for examining the current and future benefits and costs—including capital and recurring, primary and secondary—of different adaptation alternatives.

While strategic prioritization is required, there are a number of approaches which—in light of established trends of certain climate conditions, the high probability of risk, and the potential for significant impact and adverse consequences—are clearly priority candidates for implementation. One example is the early implementation of adaptation strategies that could be encouraged through incentives and incorporated into existing programs. These are termed as "no regrets" strategies—strategies that are beneficial regardless of climate change that should be encouraged where cost-effective. Innovative efforts, such as the state's StormSmart Coasts Program's work to provide coastal communities with expertise in planning for storms, floods, sea level rise, and climate change, can be improved and expanded along the coast and inland before climate change impacts are fully realized.

Strategy #5 — Support Local Communities

Many of the State's communities are already grappling with flooding, pollution, erosion, repeated storm damage, heat impacts, and other problems

likely to be exacerbated by climate change. As a home-rule state, many of the land-use decisions in Massachusetts are made by cities and towns. Managers of key assets such as water supply infrastructure or local public safety resources may not have the technical capacity or the resources to plan for climate change. Consequently, to be successful, adaptation strategies must be connected with and directly support vulnerable communities. Addressing some of these challenges at the local level will require assistance—both, technical and financial—from state and federal governments, regional planning agencies, professional trade organizations, and non-profit partners. This assistance can help to ensure that revised operating procedures, best practices for analyzing risk, guidance for implementing adaptation measures, and updated design standards for new facilities are readily accessible to local government and businesses.

Communities can also learn from one another, as some already have experiences with climate change adaptation strategies to share. Adaptation support must also extend to key businesses and industries such as local employers and vital, but vulnerable, trades such as fishing and agriculture. Building upon current programs that have demonstrated successes and efficiencies, such as the Massachusetts Office of Coastal Zone Management's StormSmart Coasts Program (see Chapter 8 for more details) and the ICLEI (International Council for Local Environmental Initiatives)—Local Government for Sustainability network, will be important. In addition to technical and planning support, financial assistance to aid communities in their efforts to implement sound climate change adaptation strategies will be critical.

ICLEI—Local Government for Sustainability

Since the early 1990s, ICLEI has led an international member network to advance climate protection and sustainability. Member communities bring experience, leadership, and the ability to create solutions to a global problem while advancing measures at the local level. The ICLEI network includes 38 Massachusetts communities who represent coastal regions from Boston Harbor and Nantucket to areas inland, such as Amherst and Pittsfield, and communities in between. This expanding network of local governments from across the state can share successes and challenges and create resilient communities together with the larger ICLEI network.

Strategy #6 — Improve Planning and Land Use Practices

With increasing climate change impacts, particularly those related to coastal and riverine flooding, society will be faced with difficult decisions regarding risk to public infrastructure, private property, natural resources, and human safety and welfare. Criteria, priorities, and policies are needed to help better inform where protection of infrastructure and other investments are necessary. In order to help fortify existing structures and minimize and prevent exposure, sound land use decisions should be promoted through technical support to local communities on consistent and effective land-use standards and guidelines, model bylaws, and state permitting processes. (See Chapter 7 for more details on land use and planning.) The Department of Fish and Game's BioMap2, provides a proactive decision support tool to inform both conservation of resilient ecosystems and areas better suited for development.

Strategy #7 — Enhance Emergency Preparedness

Hazard mitigation, evacuation, and emergency response plans should be evaluated and updated to reflect changing climate conditions and new development. In general, emergency preparedness resources have evolved in response to past emergencies and storm events. The scope, magnitude, and frequency of historic emergencies have served as the basis for the design and development of the existing emergency preparedness infrastructure. As storms become more frequent and intense and sea level rises, new and increased levels of exposure may arise, and many areas that previously escaped storm impacts will likely be vulnerable.

Managers should assess and enhance emergency management tools and capabilities in order to respond to the predicted increased frequency and intensity of extreme weather events. These tools include the State Risk Assessment Inventory, the State Comprehensive Emergency Management Plan, the State Hazard Mitigation Plan, mapping and information systems, and other emergency management tools. (See Chapter 7 for more details.)

Strategy #8 — Encourage Ecosystem-Based Adaptation

Natural ecosystems provide resilience and reduce the vulnerability of the natural and built environments. Protecting resilient ecosystems also increases their ability to thrive, and strengthens the services they support. Using natural habitats as "green" infrastructure can help impede and potentially eliminate the risk posed by some climate change impacts while supporting crucial biota, enhancing quality of life, and serving as a carbon sink.

Strategy #9 — Continue to Seek Expert Advice and Stakeholder Input

Continued efforts should also be made to ensure broad-based expert and stakeholder input. Means to engage representatives, stakeholders, and the general public should include enhanced communication efforts, formal and informal public hearings, issue-based meetings with broad partners and interests, enhanced state agency presence in local communities, and advisory groups convened for deliberation on specific research topics and policy change proposals.

Strategy #10 — Ensure Agency and Regional Coordination

There is a need for strong communication, coordination, and integration across various state agencies. Massachusetts should explore options for policy and implementation coordination across executive agencies, state and local authorities.

Climate change adaptation also needs to be addressed nationally and regionally in the Northeast. Collaboration on adaptation within and across state and federal boundaries is essential to ensure coordinated data collection and modeling activities, thereby reducing costs and minimizing duplication. Collaboration is also essential to performing multi-state assessments, planning for shared natural and infrastructure resources, and to allowing climate adaptation planners to learn and build from each other's successes and challenges.

Massachusetts is actively participating in multi-state and regional coordination and collaboration efforts on climate change adaptation. The 2008 New England Governor's Conference Resolution 32-5 entitled 'Resolution Concerning Climate Change and Adaptation' recognized the importance of needing to adapt to climate change, and committed the New England Governors and Eastern Canadian Premiers to share data and information on vulnerable areas, and coordinate decision-making and planning processes to optimize regional adaptation and mitigation strategies. The Northeast States for Coordinated Air Use Management (NESCAUM) is actively facilitating a multi-agency coordination effort to discuss adaptation efforts occurring at state and federal agencies in the Northeast and assess the need for regional collaboration between these efforts. The goal of this group is to provide a mechanism for coordination, communication, and work across sectors and states, and to develop a framework for the Northeast to address adaptation to climate change.

Going forward, Massachusetts should continue to actively participate in on-going regional collaboration efforts, share this report with regional partners, collaboratively pursue federal funding for adaptation efforts in all the New England and northeastern states, participate in regional efforts to create an online clearinghouse for climate change adaptation information, work with other states to address specific issues that cross political boundaries, foster academic collaboration, and reach out to other organizations for inclusion in future information sharing and collaborative planning for the Northeast.

Strategy #11 — Promote Communication and Outreach

Because climate change adaptation is complex, it is imperative that targeted communication efforts are in place to inform local officials, the private sector, and citizens of the potential risks and consequences of a changing climate. An ongoing strategy should be the training and skill-building of decision-makers and environmental planners to promote fluency on climate change adaptation sufficient to initiate and perpetuate action. For this, an assessment of the current knowledge, perceptions, skills, and intentions of these constituents should be conducted so that communication is appropriately focused.

Strategy #12 — Start Now, Be Bold

Enough is known about climate change science and its impacts to start to address it now. Earlier action is often cheaper and could help prevent predicted future impacts to key infrastructure resources, public health, natural systems, and the economy.

4. MOVING FORWARD

This report presents a first step toward the identification, development, and implementation of strategies that will advance the State's ability to adapt more effectively and efficiently to a changing climate. Significant challenges remain, and there is much work to be done. Under the leadership of the legislative and executive branches, and with the assistance and collaboration afforded by a broad range of partners—cities and towns, non-government organizations, academic institutions, private businesses, and stakeholder groups and individuals, Massachusetts can strategically position itself to maximize opportunities and address threats. With the submittal of this report to the Legislature, the statutory obligations of the Committee are complete. The Committee now urges the Secretary of Energy and Environmental Affairs to consider the committee's recommendations and find opportunities for action—immediately, in the short run, and the long-term—and to consider how to maintain public, expert, and stakeholder input into the ongoing challenge of adapting to climate change in Massachusetts.

REFERENCES

Ackerman, F., E. A. Stanton, C. Hope, and S. Alberth, 2009. Did the Stern Review Underestimate US and Global Climate Damages? Energy Policy 37: 2717-2721.

Ashton, A., J. Donnelly, and R. Evans, 2006. A discussion of the potential impacts of climate change on the shorelines of the northeastern United States of America. Northeast Climate Impacts Assessment, Union of Concerned Scientists.

Breslau, K., 2007. The insurance climate change: Coastal homeowners in the East are losing their policies or watching premiums skyrocket. Carriers say that global warming is to blame. Newsweek, January 29. Online at http://www.newsweek.com/id/70119. Last accessed 01/27/10.

Dailey, P., M. Huddleston, S. Brown, and D. Fasking, 2009. The Financial Risks of Climate Change: Examining the financial implications of climate change using climate models and insurance catastrophe risk models. ABI Research Paper #19; Report by AIR Worldwide Corp. and the Met Office.

Eastern Research Group, 2010. Cost-Effective Greenhouse Gas Mitigation in Massachusetts: An Analysis of 2020 Potential. Draft Report. Prepared with Synapse Energy Economics, Inc., Cambridge Systematics, Inc., Abt Associates, Inc., Stockholm Environment Institute—U.S.

Frumhoff, P. C., J. J. McCarthy, J. M. Melillo, S. C. Moser, and D. J. Wuebbles, 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

Hayhoe, K., C. P. Wake, T. G. Huntington, L. Luo, M. D. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. Degaetano, T. J. Troy, and D. Wolfe, 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Climate Dynamics 28:381-407, DOI 10.1007. Online at: www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

IPCC (Intergovernmental Panel on Climate Change), 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Avery, M. Tignor, and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, 996 pp.

Jones, C. P., W. L. Coulbourne, J. Marshall, and S. M. Rogers Jr., 2006. Evaluation of the National Flood Insurance Program's Building Standards. American Institutes for Research: Washington, DC.

Lenton, T., A. Footitt, and A. Dlugolecki. Major Tipping Points in the Earth's Climate System and Consequences for the Insurance Sector, 2009. World Wide Fund for Nature, Gland, Switzerland and Allianz SE, Munich, Germany. http://knowledge.allianz.com/climate_tipping_points_en.html.

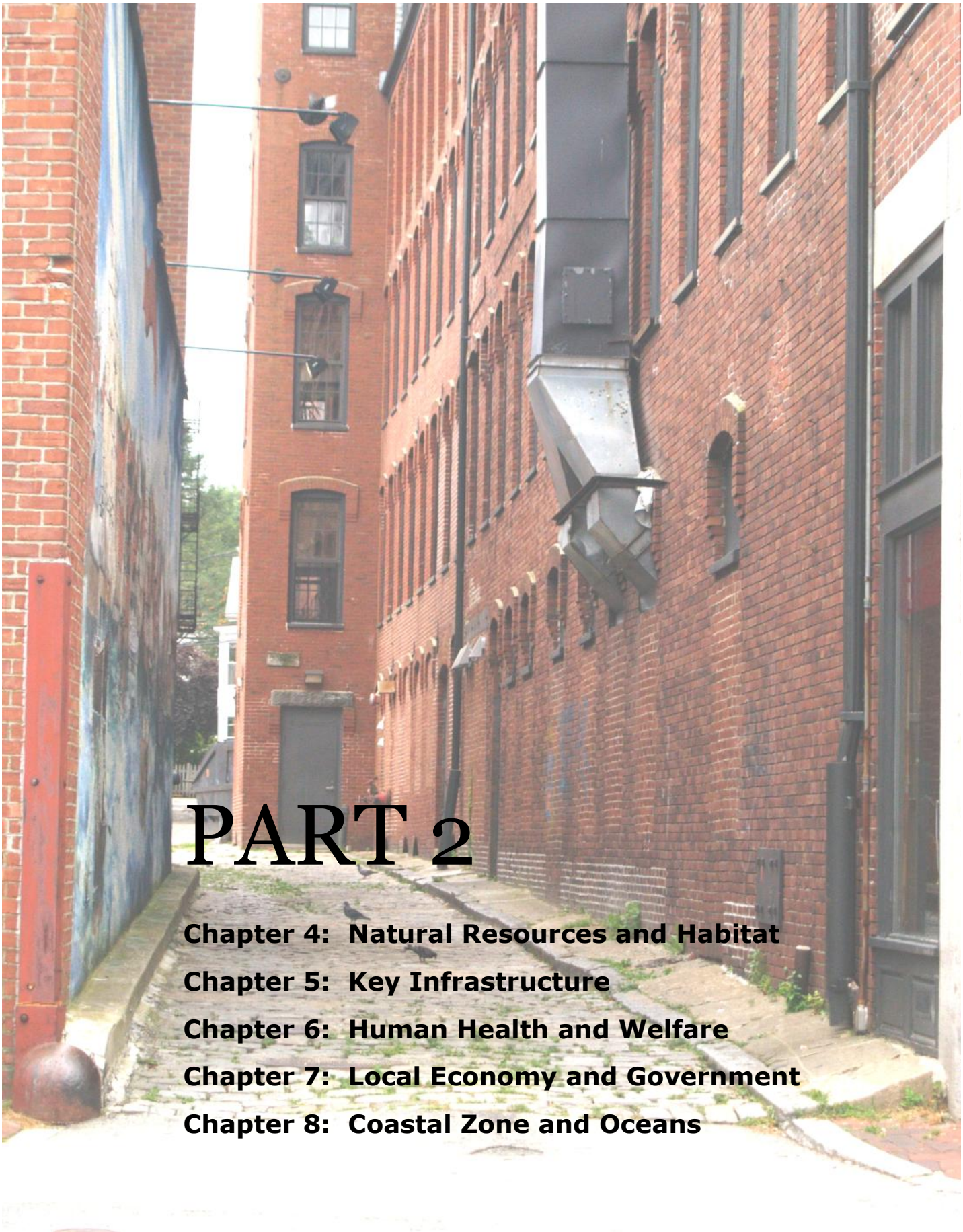
Nakicenovic N., J. Alcamo, G. Davis, B. de Vries, J. Fenhann, S. Gaffin, K. Gregory, A. Grübler, T. Y. Jung, T. Kram, E. L. L. Rovere, L. Michaelis, S. Mori, T. Morita, W. Pepper, H. Pitcher, L. Price, K. Riahi, A. Roehrl, H. Rogner, A. Sankovski, M. Schlesinger, P. Shukla, S. Smith, R. Swart, S. V. Rooijen, N. Victor, and Z. Dadi, 2000. IPCC Special Report on Emissions Scenarios. Cambridge, UK and New York, NY: Cambridge University Press.

National Oceanic and Atmospheric Administration, 2009. http://co-ops.nos.noaa.gov/sltrends/sltrends.shtml.

Pielke, R. A., and C. W. Landsea, 1998. Normalized hurricane damages in the United States: 1925-95. Weather and Forecasting 13:621-631.

Ruth, M., D. Coelho, and D. Karetnikov, 2007. The US Economic Impacts of Climate Change and the Costs of Inaction. University of Maryland: Center for Integrative Environmental Research.

Union of Concerned Scientists, 2009. Climate Change in the United States. The Prohibitive Costs of Inaction.



PART 2

Chapter 4: Natural Resources and Habitat

Chapter 5: Key Infrastructure

Chapter 6: Human Health and Welfare

Chapter 7: Local Economy and Government

Chapter 8: Coastal Zone and Oceans

4 — NATURAL RESOURCES AND HABITAT

SUBCOMMITTEE CHAIRS:

Andrew Finton	The Nature Conservancy
Jack Buckley	Department of Fish and Game

ADVISORY COMMITTEE PARTICIPANTS:

Taber Alison	Massachusetts Audubon
David Foster	Harvard Forest
Hector Galbraith	Manomet Center for Conservation Sciences
Wayne Klockner	The Nature Conservancy
Bernie McHugh	Massachusetts Land Trust Coalition
Peter Weiskel	U.S. Geological Survey

OTHER CONTRIBUTING MEMBERS:

Kathleen Baskin	Executive Office of Energy and Environmental Affairs
Rick Bennett	U.S. Fish and Wildlife Service
Kate Bowditch	Charles River Watershed Association
Chris Busch	City of Boston
Anne Carroll	Department of Conservation and Recreation
Gillian Davies	BSC Group, Inc.
Heidi Davis	Department of Environmental Protection
Hunt Durey	Department of Fish and Game
Scott Jackson	University of Massachusetts–Amherst
Laura Johnson	Massachusetts Audubon Society
Thomas Kyker-Snowman	Department of Conservation and Recreation
Steve Long	The Nature Conservancy
James MacCartney	Trout Unlimited
Robert O'Connor	Executive Office of Energy and Environmental Affairs
John O'Leary	Department of Fish and Game
Antonia Pollack	City of Boston
Tim Purinton	Department of Fish and Game
Vandana Rao	Executive Office of Energy and Environmental Affairs
Celia Riechel	Executive Office of Energy and Environmental Affairs
John Scanlon	Department of Fish and Game
Caleb Slater	Department of Fish and Game
Jan Smith	Office of Coastal Zone Management
Lisa Vernegaard	The Trustees of Reservations

INTERNS:

Cassandra Snow, Craig Altemose

4 Natural Resources and Habitat

Introduction

Since climate is a major determinant of ecosystem function and the distribution, abundance, and behavior of organisms, climate change is likely to trigger fundamental responses in and alterations to Massachusetts ecosystems. Climate change will have a significant impact on the biological diversity of Massachusetts and the Northeast as northern, cold-adapted, niche species are lost or replaced by more southern generalist species. Ecological relationships and processes will be undermined by climate change, and there remain many uncertainties in our understanding of ecological response.

Ecological changes in response to climatic change have been observed in the northeastern United States, as plants leaf out and bloom earlier (Wolfe et al., 2005), amphibian breeding seasons start earlier (Gibbs and Breisch, 2001), and Atlantic salmon spring migrations begin sooner (Juanes et al., 2004). In addition to these direct impacts, species and ecosystems face a broad range of indirect climate-related threats. Two examples are the way temperature changes cause decoupling of bird migration and food source timing and provide a competitive advantage to non-native insects and plants.

It is also important to recognize that the observed ecological changes in North America and elsewhere have occurred under a relatively modest average global temperature increase of only 0.74°C (1.3°F); the additional increase of 3° to 5°C (5° to 10°F) predicted for the Northeast is likely to have increased impacts on ecosystems.

This chapter addresses vulnerabilities and adaptation strategies for four ecosystem types: forest, coastal, aquatic, and wetland. The chapter examines these broad ecosystem types to provide a better understanding of how climate change will affect fish, wildlife, plants, and natural resource functions and ecosystem services over time, across the state, and within regions. Strategies that enhance the functions of these ecosystems can also significantly benefit the economy, infrastructure, public health and safety, coastal resources, and other sectors.

Current Stressors

Evaluation and assessment of the impacts of climate change to natural systems, and strategies to abate these threats, should be conducted in the context of current stressors on ecosystems and populations such as: the loss of habitat and ecosystem function caused by development, fragmentation, invasive species, or other threats. These stressors will continue to be a persistent factor affecting the viability of natural systems. In fact, even without the additional threat of climate change, many elements of the state's biodiversity face an uncertain future. Climate change is occurring at such a rapid rate that changes to species and ecosystem function may occur in a disruptive way resulting in loss of species and ecological values.

Economic Benefits of Natural Resources

Healthy and functional ecosystems support several important sectors of the economy and provide valuable social benefits (TEEB, 2009). Having resilient ecosystems can buffer these ecosystem services against the significant impacts that are occurring or are projected to occur due to climate change.

Intact forested watersheds, wetlands, and rivers support clean drinking water and help water suppliers avoid the need for billions of dollars of water purification infrastructure and operations. Protecting functional floodplains and other wetlands prevents the need for additional flood control infrastructure and flood damage repairs. Coastal wetlands act as important natural buffers that prevent storm and flood damage to expensive inland infrastructure. Estuaries are the breeding ground and nurseries for many species of marine organisms that play important ecological and economic roles.

An added benefit of healthy and properly functioning ecosystems is improved resistance to invasive plants, animals, insects, and diseases. As a result, fewer resources are needed for control of these ecologically and economically costly threats. Forests and other naturally vegetated landscapes sequester atmospheric carbon, equivalent to approximately 10 percent of Massachusetts' carbon emissions. Conservation of wetland soils with significant carbon stores (i.e., peat) also prevents the release of additional carbon to the atmosphere.

It is estimated that each acre of forest in Massachusetts provides $1,500 annually in economic value from forest products, water filtration, flood control, and tourism. For the state's 3.1 million acres

of forest, this equals $4.6 billion annually (Campbell, 2000).

About 40 percent of Massachusetts residents who are 16 years or older engage in wildlife-related recreation, contributing slightly more than $1.6 billion to the Massachusetts economy. The multiplier effect on the Massachusetts economy of the direct expenditure of $1.6 billion dollars is approximately $2.6 billion. This supports about 27,000 jobs, providing $975 million in wages, $213 million in state income and state tax revenue, and $243 million in federal revenue.

Forest harvesting directly supports 3,700 jobs for foresters, loggers, sawmill workers, and wood processing plant workers in Massachusetts; the wood products industry produces over $385 million of goods annually (American Forest and Paper Association, 2011).

Overall Vulnerabilities

There are similar vulnerabilities across ecosystems based on projected changes in temperature, precipitation (timing and amount), increased storm intensity, drought and the number of extreme heat days, sea level rise, and increased coastal storm surge. Many of these parameters affect ecosystem processes (e.g., stream flow), individual species and populations.

What forms will these changes take? Until recently, our dominant model of change was for habitats to slowly replace each other as their optimum climatic conditions shifted. Thus, we might expect to see the highly vulnerable spruce-fir forests at upper elevations replaced by northern hardwood forest as it moves upslope to track its optimum climatic conditions. This model of entire communities shifting is important in evaluations of what may occur to habitats under climate change. However, this model may not fully represent what actually could occur.

Different organisms have different intrinsic rates of response to climate change. For example, a northeastern warbler such as the American redstart can potentially shift its breeding range northward by several hundred kilometers in only a few days. Yet, the majority of the plants that make up the breeding habitat of this species are far less able to respond as rapidly. Rather than entire ecosystems or communities shifting their distributions across the landscape, we may see them dissociating and separating, then reconfiguring into potentially novel combinations upslope or further north or not reconfiguring at all. This dissociation and reconfiguring has become the dominant model of how ecological communities may be affected by climate change.

The overall approach to assessing the potential vulnerabilities of natural resources to climate change and development of adaptation strategies is presented in the Figure 7.

This chapter assesses the relative vulnerabilities of the state's various habitat types. Each ecosystem category is reviewed for specific associated functions (e.g. biodiversity, flood attenuation) and assessed for the impact to and vulnerabilities of individual functions. These results are used to develop potential adaptation strategies which, if implemented, could help ecosystems resist climate effects, make vulnerable ecosystems more resilient, and assist ecosystems likely to be lost to move into new structures and functions. This analysis represents a generalized assessment that can be informed and refined by other assessments being conducted by the Manomet Center for Conservation Sciences, The Nature Conservancy, the Division of Fisheries and Wildlife, and others.

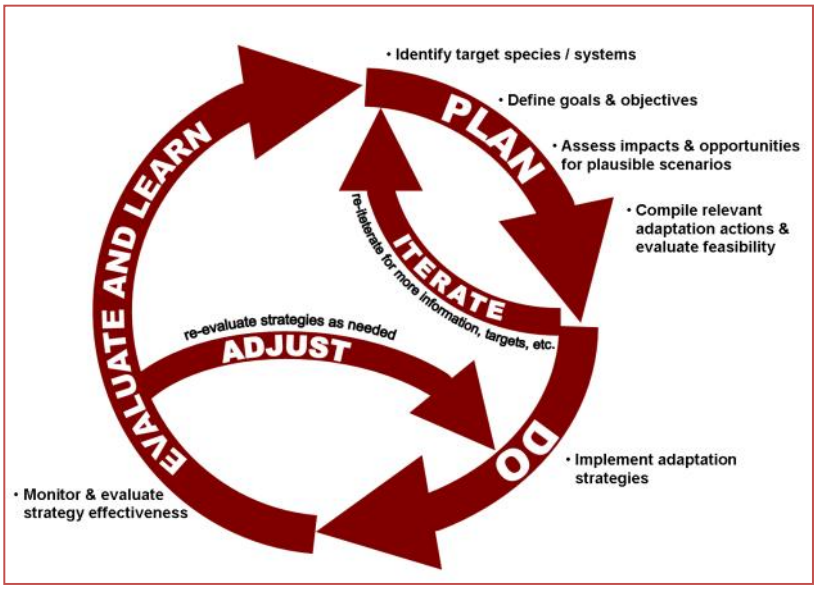


Figure 7: ***Climate change adaptive management framework***
Source: Adapted from Glick et al. (2009); Heller and Zavaleta (2009)

This analysis does not look at direct potential impact to specific fisheries, wildlife and plant species and populations. The assumption is that health and diversity of ecosystems serve as a surrogate for maintaining biological diversity. Nevertheless, significant changes in natural communities and populations will occur as a consequence of climate change and these changes may have significant impacts on diversity and status of populations, societal perception of wildlife, and public health.

Adaptation Strategies

In general, adaptation strategies for natural resources and habitats include land and water protection (such as acquisition and easements), land and water management, regulation changes, targeted public funding, increased agency cooperation and coordination, and enhanced and focused monitoring.

All of these adaptation strategies should be used in an adaptive management framework (Figure 7). These adaptation strategies may be used to resist climate change impacts on important habitats to increase habitat resilience or, when habitat vulnerability to climate change impacts is great, to facilitate change from one habitat type to another. Many of these strategies will also serve to mitigate the effects of climate change by sequestering carbon.

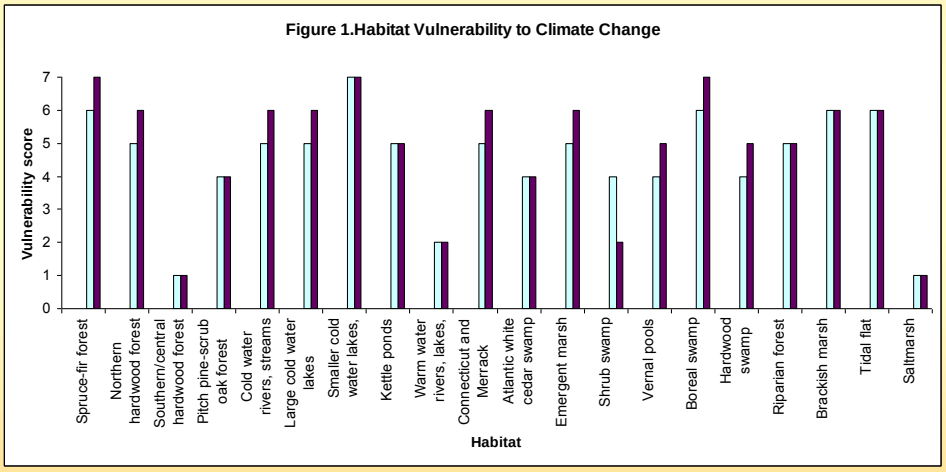
It is anticipated these adaptation strategies will be implemented by a broad array of partners including federal, state, and local governments, non-governmental organizations, and others. Significant progress is already being made toward coordinated action through entities such as the Massachusetts Climate Change and Wildlife Alliance (www.climateandwildlife.org).

Climate Change Habitat Vulnerability Rankings: Climate Change & Wildlife Management

Massachusetts agencies are taking steps to develop stronger science-based information so that their climate change related decisions will be better informed. Funded by a grant from the Wildlife Conservation Society, the Manomet Center for Conservation Sciences began working in early 2008 with the Massachusetts Department of Fish and Game's (DFG) Division of Fisheries and Wildlife (MassWildlife) and other partners, including The Nature Conservancy, to improve "climate-smart" criteria in the existing State Wildlife Action Plan (SWAP). The SWAP is MassWildlife's "blueprint" for future conservation in Massachusetts.

A panel of experts drawn from MassWildlife, the Manomet Center, and The Nature Conservancy conducted assessments of 20 key Massachusetts habitats with the following questions in mind:

- How do the fish and wildlife habitats rank in terms of their likely comparative vulnerabilities to climate change?
- How will the representation of these habitats in Massachusetts be altered by a changing climate?
- What degree of confidence can be assigned to the above predictions?
- Which vertebrate species in greatest need of conservation are likely to be most vulnerable to climate change?



Note: *The left bar in each pair represents a doubling of CO2, while the right bar is a tripling of CO_2.*

The comparative vulnerabilities of the habitats were evaluated under two emissions scenarios and scored on a vulnerability scale. The study also identified likely future ecological trajectories, assigned confidence scores, and identified other non-climate stressors that could interact with and exacerbate the effects of climate change. The analyses show that different ecological systems are more or less vulnerable to climate change and, consequently, that we can expect to see major changes in their distributions across the Massachusetts landscape.

The results of this project are presented in a series of reports. This first report, "Climate Change and Massachusetts Fish and Wildlife: Introduction and Background," provides background to the project by describing how biodiversity conservation is currently carried out by MassWildlife; the history, objectives, and methods of the SWAP; and how the climate in Massachusetts has been changing and is expected to change over the remainder of this century. The subsequent reports, "Climate Change and Massachusetts Fish and Wildlife: Habitat and Species Vulnerability" and "Climate Change and Massachusetts Fish and Wildlife: Habitat Management," address habitat and species vulnerabilities, likely ecological shifts under climate change, and potential management/conservation options. A detailed review of the findings is found on the DFG website at: http://www.mass.gov/dfwele/climatechange.htm

Guiding Principles

While many strategies are unique to specific ecosystems (e.g. allowing inland migration of coastal wetlands in the face of rising sea levels) and are detailed in the following sections, many no-regrets climate adaptation approaches apply to all ecosystem types that help protect and restore ecological resilience. Several principles rooted in ecology, conservation biology, and ecosystem management, and well-supported in current climate adaptation literature (Heller and Zavaleta, 2009; Mawdsley et al., 2009; Beier and Brost, 2010) serve as core climate adaptation strategies:

- Protect ecosystems of sufficient size—Anchor conservation in sites of sufficient size and quality to remain resilient over centuries, recover from disturbances, maintain space for the breeding requirements of component species, allow space for dynamics, and protect internal gradients and topographic variation.
- Protect ecosystems across a range of environmental settings—Represent key geophysical settings across gradients reflecting combinations of topography, geology, and elevation. Focus conservation efforts on places that are critical to biodiversity in the present and are likely to be critical in the future.
- Protect multiple example ecosystems to capture redundancy—It is unlikely that conservation will succeed at every site, as future climate is complex and local—and regional-scale impacts are unpredictable. Protecting replicate sites in many independent places ensures that at least some examples will persist through centuries.
- Maintain large-scale ecosystem processes and prevent isolation—Ecosystems and species are dependent on regional scale processes such as hydrologic cycles and disturbance regimes. It is important to maintain high quality source breeding habitats and connectivity across habitats to facilitate species dispersal, migration, and maintenance; protect local connectivity for individuals, as well as regional movements of populations to facilitate climate change adaptation; protect land and water; and identify compatible land uses in areas critical to connectivity. Intact landscapes that capture the most robust examples of ecosystems represent the best opportunities to protect and enhance ecosystem function and biodiversity.
- Limit ecosystem stressors—Strategies that focus on reducing threats, such as habitat conversion and fragmentation (i.e., development), invasive species, and airborne and waterborne pollutants, can maintain ecosystem resilience and allow ecosystems to provide a full range of functions and services.
- Maintain ecosystem diversity—Preserve as many options as possible for natural adaptation in response to climate change. Expect and plan for species losses and possible gains from other regions.
- Use nature-based adaptation solutions—Allowing intact forest, wetland, river, and coastal ecosystems to function as "green infrastructure" that protects ecological, economic, and social values is an economical climate adaptation approach. These "soft engineering" should be considered wherever possible as alternatives to "hard engineering" solutions. As an example, where appropriate, protection of coastal wetlands can be an alternative to coastal armoring for reducing the impacts of sea level rise and storm surge.

BioMap2

The Massachusetts Department of Fish & Game's Division of Fisheries and Wildlife and Natural Heritage and Endangered Species Program (NHESP), in partnership with The Nature Conservancy's Massachusetts Program, developed BioMap2 to protect the state's biodiversity in the context of projected effects of climate change.

BioMap2 combines NHESP's 30 years of rigorously documented rare species and natural community data with spatial data identifying wildlife species and habitats that were the focus of the Division of Fisheries and Wildlife's 2005 State Wildlife Action Plan (SWAP). BioMap2 also integrates The Nature Conservancy's assessment of large, well-connected, and intact ecosystems and landscapes across the Commonwealth, incorporating concepts of ecosystem resilience to address anticipated climate change impacts.

Protection and stewardship of BioMap2 Core Habitat and Critical Natural Landscape are essential to safeguard the diversity of species and their habitats, and intact and resilient ecosystems, across Massachusetts. A summary report and interactive web viewer can be found at: http://www.mass.gov/dfwele/dfw/nhesp/land_protection/biomap/biomap_home.htm.

- Embrace adaptive management—Ecosystem managers should develop flexible concepts for understanding natural systems. The effectiveness of protection and management should be verified through monitoring, and long-term ecological monitoring projects that inform climate adaptation decisions should be supported.
- Develop a unified vision for collaborative conservation of natural resources—Analyses such as the State Wildlife Action Plan and BioMap2 (2010) serve as blueprints for ecosystem protection and restoration and galvanize the conservation community to engender long-term ecological resilience. Public funding and progressive, flexible, and climate-responsive regulations will be crucial to abate the threats of climate change on natural resources and provide long-term protection of green infrastructure.

Forested Ecosystems

Existing Resources

Forests covered the great majority of Massachusetts prior to European settlement. Then, in the 18th and 19th centuries, there was dramatic alteration of the forest landscape due to logging practices and the conversion of forest to agriculture (Foster et al., 1997). Today, about 62 percent (three million acres) of the approximately five million acres of Massachusetts is forested (Alerich 2000) and over 90 percent of that is upland forest (MassGIS).

There are many forest types in Massachusetts, including spruce/fir and pitch pine/scrub oak. Two general types of upland forest occur in Massachusetts—namely northern hardwood (beech, birch, maple) forest in western and north-central Massachusetts, and central hardwood (oak, hickory) forest in eastern and south-central Massachusetts. Within the northern hardwood region, the northern hardwood-hemlock-white pine type is most common, with the spruce-northern hardwood type occurring only in the higher elevations. Within the central hardwood region of Massachusetts, oak-hickory-white pine-hemlock is most common, with pitch pine -oak occurring on the relatively infertile, sandy soils associated with coastal areas of eastern Massachusetts and portions of the Connecticut River valley in central Massachusetts.

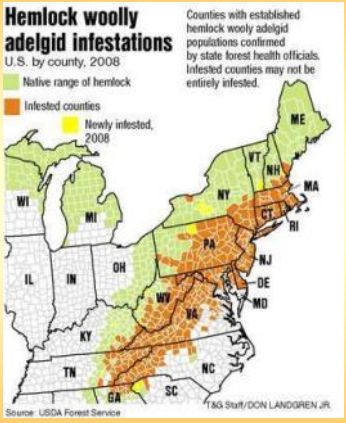
Upland forests provide important functions including support for a variety of habitats and wide-ranging biological diversity, purification of air and water, moderation of subsurface and overland water flow, and the sequestration of carbon in both the above-ground growing vegetation and in the organic components of forest soils. In addition, forests provide scenic, recreational, and tourism benefits and a rural quality of life for many citizens.

Upland forests also provide energy to streams in the form of organic material. Small streams rely on this energy almost exclusively to initiate their trophic interactions and food webs. These forests provide important filters along wetlands, rivers, and streams. Upland forests stabilize soils and sediments in often high-gradient streams, thus minimizing erosion; help to moderate temperature by providing shade to small streams; provide important habitat for wildlife species that occupy vernal pools; and provide either direct or indirect habitat benefits to wildlife species including forest-dependent species, such as warblers and thrushes, and forest dwelling salamanders, such as marbled and Jefferson salamanders.

Terrestrial Invasive Species—The Hemlock Woolly Adelgid

One pest that appears to be expanding its habitat as a result of climate change is the Hemlock Woolly Adelgid. This small, almost microscopic creature from Japan feeds on and destroys hemlock trees. Here in the U.S., it has no natural predator, and has been severely thinning hemlock populations. Some believe it will eliminate the entire hemlock population in the Southern Appalachians within the next decade. Colder temperatures have limited the agelgid's northern spread, but as winters become milder in New England, experts expect the agelgid to continue its march north.

The insect has already found its way into Massachusetts. In 2001, the state authorized $60,000 to introduce 10,000 Japanese lady bugs to eat the adelgid. While the numbers of adelgid decreased after a particularly cold winter, the lady bug population seems to have largely vanished, and it is making a comeback. The town of Weston, MA spent $5,000 in the fall of 2008 to treat 100 trees, and has authorized further expenditures of $25,000. While treatments on individual and wide scale levels can help keep the numbers of adelgid in check, there is no permanent solution or preventive defense. Continued vigilance will be required to maintain the existing Hemlock populations.



Impacts and Vulnerabilities

Climate change will cause changes in species composition and forest structure. While common species such as maples may decline in abundance and oaks may increase under climate change, more vulnerable species such as spruce may be extirpated from portions of the state or their distribution may be significantly reduced. Climate change, in conjunction with other stressors, will alter forest function and its ability to provide wildlife habitat, and could reduce the ability of forests to provide ecological services such as air and water cleansing.

Massachusetts can experience a greater intensity and frequency of forest-disturbing weather events, including ice storms, localized or regional wind events such as microbursts or hurricanes, and more frequent and longer droughts and associated wildfire. All of these conditions can suddenly kill or alter the vigor of native trees, thereby opening the forest to new species. The same climate change phenomena that affect trees could also impact forest-dependent species such as song birds, forest floor plants, and invertebrates, as well as disrupt predator-prey relationships, and alter phenological patterns and other, often complex, ecological processes. Some changes may be slow while others may proceed quickly once critical thresholds are met (e.g., forest pests).

Predicted change in species composition from increased ambient temperatures is generally a function of the extension of northern limits of species that have limited cold tolerance and a change in the habitat suitability. Range shifts in tree distribution (historically, forest types have shifted at the range of 12 to 15 miles every 100 years) will change the relative proportions of forest tree species. The migration of tree species in response to habitat changes, however, is likely to be much slower than the predicted changes in habitat due to climate change. It is also important to note that movement is likely to occur at the individual species level and not by groups of species. The speed at which these impacts take place may come either quickly or over decades. Northern forest types such as spruce-fir will likely disappear from Massachusetts. Red spruce and balsam fir will likely have decreasing reproductive success, northern hardwoods will recede to higher elevations within the state and northward out of the state, and southern forest types such as central, transitional, southern hardwoods will likely increase in abundance. Changing climate factors and forest types will also likely alter the composition and role of myriad other species defining forests including vertebrates, invertebrates, shrubs, herbs, non-vascular plants, fungi, and bacteria.

Invasive insects and diseases will also respond to climate change; hemlock woolly adelgid is likely to expand northward while the response of others, such as the emerald ash borer, the Asian longhorned beetle (currently attacking hardwoods in Worcester), or the widespread beech bark disease, is uncertain. Overall, the negative impacts of invasive species may increase as native forests are increasingly stressed and become more vulnerable to changes in mean and maximum air temperatures and subsequent changes in the water cycle.

The following strategies could be considered for implementation to mitigate potential climate change impacts on forest resources.

Potential Strategies

For a forest ecosystem to maintain its biodiversity, it should be able to absorb small perturbations, prevent them from amplifying into large disturbances (resistance), and return to the original level of productivity, function, structure and, in some cases, species composition following a disturbance (resilience). The resistance and resilience of ecosystems are dependent on their sizes, conditions and landscape contexts.

1. Land Protection—Secure Large Unfragmented Forest Blocks

Forest ecosystem functions can be greatly impaired by forest fragmentation caused by roads, development, and infrastructure. To maintain these functions, an important climate adaptation strategy is to identify and protect resilient forest ecosystems—both forest reserves and actively managed forests—based on the principles outlined in the guiding principles section of this chapter.

2. Policy, Flexible Regulation, Planning, and Funding

Consider establishing landowner incentives for forest ecosystems. Because nearly 80 percent of forests in Massachusetts are privately owned, incentives for private land owners to keep their forest lands as forest and manage them for compatible natural resource values will be crucial for both climate adaptation and mitigation (i.e. carbon sequestration) strategies, as such incentives are less costly than purchasing these parcels as conservation land. These potential strategies are,

a. Establish mechanisms to pursue a goal of "no net loss of forests," such as funding for technical assistance to implement smart growth and reduce development footprint on forests, mitigation requirements for forest conversions, and to increase tree planting in

Government Takes the Initiative

Over the last four years, the Massachusetts Executive Office of Energy and Environmental Affairs and its agencies have invested an unprecedented $218 million to permanently protect more than 85,000 acres of land and create or restore 114 urban parks.

urban/suburban open land. This could add to permanent forest conservation of key wildlife corridors for climate adaptation and of exceptionally productive forests for sequestration.

b. Add state tax incentives to "keep forests as forests," including a state tax credit for the cost of professionally prepared forest management plans (the main impediment to adding acreage to the state Forest Tax Law).

c. Establish an initiative to promote the buying of local forest produce.

3. Management and Restoration

For greatest resilience and adaptability, Massachusetts forests should exhibit a balance of forest structure, composition, and age classes across the state and across ownership, as well as a mix of approaches to forest management, with forest reserves controlled by natural processes, as well as actively managed forests that provide forest products in addition to carbon sequestration and other functions and services. This goal may be achieved through the following strategies.

a. Reserve Management. Encourage forest reserve management to allow natural processes to determine the long-term structure, composition, function, and dynamics of the forest to the maximum extent possible. Use the general approach and the Forest Reserve Management Guidelines developed as a result of the Department of Conservation and Recreation's (DCR) Forest Futures Visioning process and informed by EEA's Forest Reserve policy developed in the early 2000's.

b. Reserve Selection and Designation. For forest reserves to maintain their ecological function over long periods, forests managed as reserves should be large (The Nature Conservancy recommends >15,000 acres each), minimally fragmented, and representative of varied ecological settings that define Massachusetts' forest biodiversity. The Forest Futures Visioning process recommended that DCR designate the approximately 310,000 acres of land within the forest and parks system as Reserves, Parklands, and Woodlands to prioritize the ecosystem services these lands provide.

c. Manage invasive species. Launch an initiative to remove invasives from large unfragmented forest blocks on state land in collaboration with non-profit partners. Invasive exotic plants homogenize a forest, reduce the diversity of species composition, and weaken resistance to change. Established procedures can reduce the impact of forestry practices on the spread of invasive species (e.g., cleaning of machines to remove seed or root cuttings before moving to a new site), monitoring for their presence and controlling them early.

d. Protect regeneration. Delays in regeneration reduce the ability of the forest ecosystem to function consistently over time. Manage activities that limit the ability of native trees, wildflowers and herbs to regenerate, such as over-browsing by white-tailed deer and damage from all terrain vehicle (ATV) activity.

e. Practice prudent fire management. In fire adapted and fire dependent forest types (e.g. pitch pine-scrub oak), utilize current fire management practices to maintain the ecosystem processes and breadth of biodiversity of these systems. Consider establishing a fire management council to facilitate prescribed fire management in fire-adapted pitch pine/scrub ecosystems on a landscape scale. More frequent and pronounced droughts are expected to couple with an overall increase in forest growth, and this combination would mean that fire-adapted systems could see increased frequency and/or intensity of fire and associated risk to human life and property.

f. In some cases, enhance sequestration through planting. Planting native seed stock of local genetic origin in these stands can

Forest Reserve Management in Massachusetts

The Massachusetts Department of Conservation and Recreation (DCR) is implementing the Forest Reserve Management Guideline recommendations and will designate over 100,000 acres of DCR lands as Reserves within eleven "Ecological Land Units" that capture the forested settings of the Commonwealth. In addition, "Parklands" which will make up approximately 75,000 acres of DCR lands, will be managed primarily for recreation, human experiences and cultural values. Reserves and Parklands will be set aside from active forest management. DCR will designate approximately 120,000 acres of "Woodlands" to be managed as demonstration forests, focusing on restoring late successional conditions and sustainable production of timber.

return the forest to full stocking. This increases capacity to sequester carbon while also increasing resilience. In the absence of browsing pressure or dense invasive species, forests will naturally regenerate to fill gaps produced by disturbances.

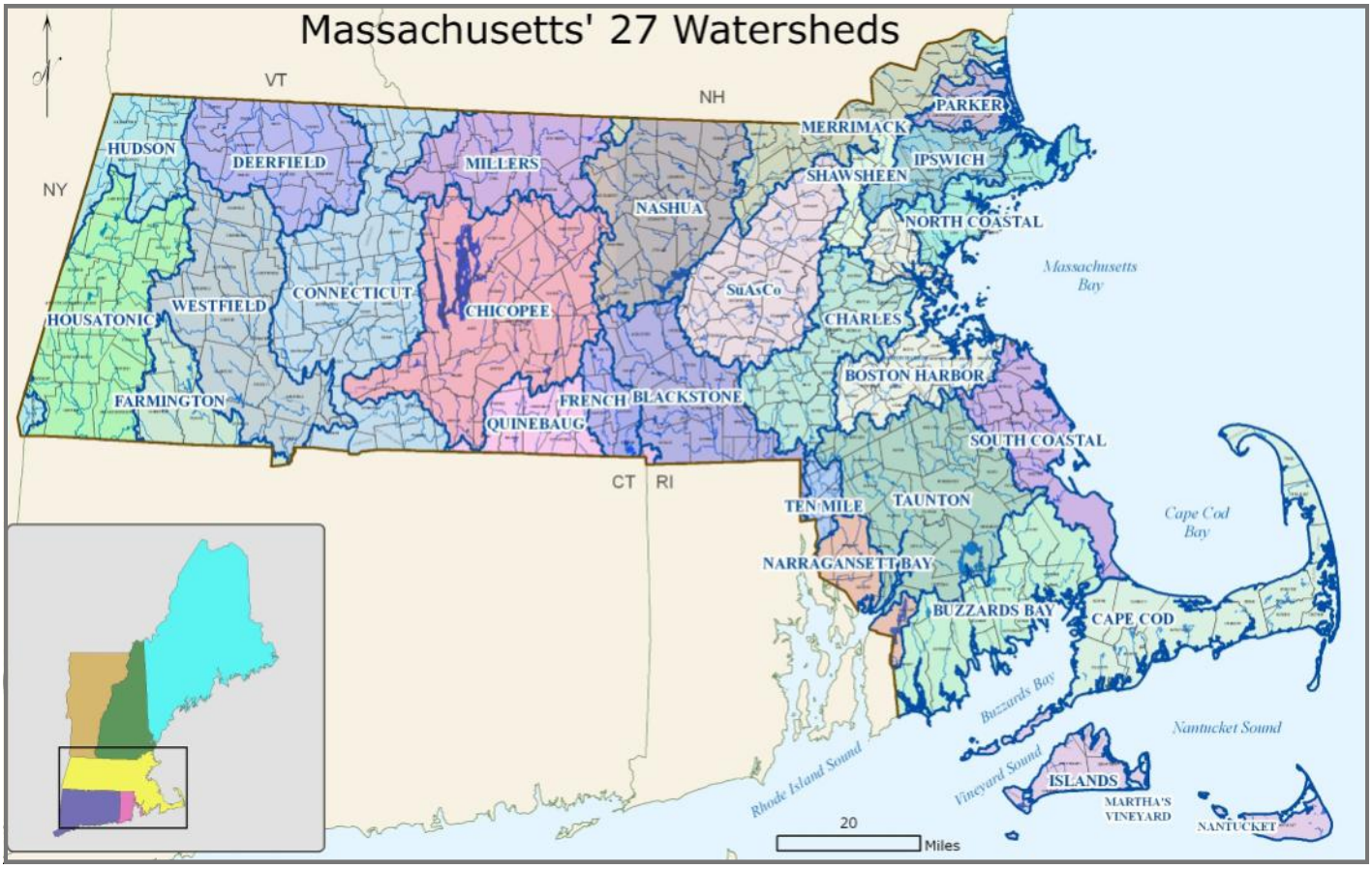
4. Monitoring, Research, and Adaptive Management. Support long-term ecological monitoring programs such as the DCR's Continuous Forest Inventory, a data set collected over 50 years which provides invaluable information on the status and trends of the state's forest resources), and the joint DCR/MassWildlife/University of Massachusetts program for long-term monitoring of plant community dynamics on paired forest reserves and actively managed state lands.

Aquatic Ecosystems

Aquatic ecosystems refer to rivers, streams, lakes, and ponds. Although many ecologists consider wetlands and salt marshes under this category, these systems are addressed in separate sections in this report.

There are 27 major river basins in Massachusetts. Mainstem rivers such as the Connecticut and Merrimack are characterized by wide, low gradient streambeds meandering through broad river valleys with extensive flood plains. Large and mid-sized mainstem rivers and their larger tributaries vary considerably, but have some common features. Moving from their headwaters to their mouths, gradient in these rivers typically declines and sediment sizes decrease. Organically enriched soils become more widespread as floodplains widen, due to deposition of organic material in slower moving waters. These rich floodplains are the foundation for productive floodplain forests, shrub swamps, and other habitats. However, floodplain forest is already one of the most uncommon and degraded ecosystems in Massachusetts (Swain and Kearsley, 2001), and faces further threat from a combination of earlier spring runoff, more frequent low flow conditions (during spring runoff and summer droughts), and more frequent high flow conditions (during winter flood events). This combination would fundamentally alter the hydrologic periodicity of these dwindling riparian ecosystems, likely favoring invasive, exotic plant species, which are already a major threat to these unique areas.

Small streams in the upper reaches of a watershed originate where rainfall, runoff, and groundwater first come together to form defined stream channels, typically with year-round flow. These streams account for the majority of the linear stream miles in



Massachusetts. They accumulate and assimilate all upstream inputs, perturbations, and degradations and transmit them to reaches downstream. In most cases, small streams rely on groundwater for a high percentage of their annual flow and have food webs that are highly dependent on additions of nutrients from the surrounding vegetation. These streams often have naturally low fish diversity, low productivity and relatively high gradients. The substrates may be dominated by boulder and cobble in high-gradient watersheds like the Westfield River, or gravel and sand in lower gradient watersheds like the Taunton River. It has long been realized that healthy small streams contribute to the integrity of a watershed by maintaining the soil, increasing infiltration, reducing the impacts of flooding, and maintaining summer base flow. These functions not only support biodiversity, wildlife, and river processes, but also provide crucial flood control services and drinking water protection.

Massachusetts has nearly 3,000 named lakes and ponds, totaling over 150,000 surface acres. Some lakes, such as the kettlehole ponds on Cape Cod, were naturally formed over 10,000 years ago during the retreat of the last Ice Age. While many of the state's lakes and ponds were created or enhanced by dams and are thus positioned at the headwaters to streams and rivers, they are a crucial link in the overall aquatic community. Many of these lakes and ponds support drinking water and recreational needs in addition to providing habitat for a wide variety of fish and wildlife.

Impacts and Vulnerabilities

Aquatic ecosystems are vulnerable to climate change. Predicted changes in timing, frequency, and duration of precipitation events, more intense storms, a shift from winter snow to rain, more frequent and longer summer droughts, and increases in temperature trends and extreme high temperatures will affect both lotic (flowing water) and lentic (still water) habitats.

Water quality and quantity are expected to be adversely affected by predicted increased temperature, drought, an increase in the number of extreme heat days, and a decrease in summer precipitation. Higher temperatures, along with changes in stream flow, will degrade water quality. Warmer, drier conditions will lead to deeper and stronger thermal stratification in lakes which will decrease the volume of the deeper, cooler, well oxygenated water that is critical summer habitat to a number of species. As a result, this habitat may be eliminated from many shallower lakes and ponds. In addition, non-native species will likely become a bigger problem for lake and stream ecosystems under warmer conditions (Ramsar, 2002). In general, climate change can influence the establishment and spread of invasive species and can reduce resilience of native habitats to these species (U.S. EPA, 2008). Increased mobilization of non-point source nutrients, and suspended solids from more intense winter rain storms, followed by higher summer temperatures, will result in more algal blooms (e.g., blue-green algae) and vigorous growth of aquatic vegetation leading to eutrophication in lakes and impounded rivers.

A projected increase in average winter temperatures will decrease the amount of snowpack and ice and negatively impact aquatic ecosystems. Reduced ice cover on lakes and ponds will result in more winter sunlight and more abundant aquatic vegetation, while less melting snowpack will reduce spring groundwater recharge. A shift to winter rains will potentially lead to more runoff, flooding, greater storm damage, scour, and erosion during a time when there is reduced vegetative cover and low evapotranspiration (the combination of evaporation from the ground and transpiration from plants) during the winter months. Peak river flows are predicted to occur earlier as higher average temperatures and a shift from winter snow to rain accelerate the spring melt. Flooding, and an accompanying loss of vegetative cover, could reduce many ecological functions, causing effects such as reduced primary productivity and loss of carbon storage; degradation of wildlife habitat, in-stream aquatic habitat, and water quality; and increased incidence of water-borne disease, sedimentation, pollutant loading of waterways, and surface runoff (Ramsar, 2002). In waterways and waterbodies, increased temperatures are likely to cause loss of thermal refuges for coldwater species, decreases in dissolved oxygen, changes to hydrologic mixing regimes, and changes in biogeochemical cycling (Ramsar, 2002).

Higher summer temperatures, less summer precipitation, and an increase in drought frequency and duration will affect both water quantity and quality. Some intermittent streams may cease flowing earlier in the season and more frequently and some perennial streams may become intermittent. In some rivers and streams, coldwater

habitat will be replaced by warm water habitat. This will likely be accompanied by marked changes in the species that live in these habitats.

Climate change can affect fisheries through changes in abundance, distribution, and species composition. Fisheries in small rivers and lakes are believed to be more susceptible to changes in temperature and precipitation than those in larger rivers and lakes (Ramsar, 2002). As coldwater habitats warm, coldwater fisheries, which are already stressed by reduced habitats and population losses, will be especially affected. Though some adult fish may tolerate higher stream temperatures, in certain circumstances they will not reproduce. Climate change may affect stream flow by increased flooding incidences from extreme precipitation events, and low flow occurrences in late fall. Flooding, in turn, can scour stream bottoms where fish eggs are lodged. The earlier seasonal growth of plants could result in lower stream base flows earlier in the spring and negatively affect primary productivity.

The predicted changes in precipitation patterns can also increase stormwater discharge, which can affect both water quantity and quality. Hydrologic changes from increased flooding can amplify erosion and scour in streams and initiate channel incision. Problems associated with channel incision include undermining of structures, downstream sedimentation, severe bank erosion and widening, and degradation of aquatic and riparian habitats. Overbank floods that once spilled across the floodplain can become confined within the channel, and the river can get disconnected from the floodplain, leading to a loss in the ability of the floodplain to provide flood storage, storm damage prevention, groundwater recharge, pollution attenuation, sediment transport/storage, and protection of water quality. Under these conditions, flora and fauna that are adapted to a floodplain environment may experience a loss of habitat and range. Without periodic inundation, there would be a loss of wetlands and fisheries-related hatching and nursery areas.

As rivers incise, their banks fail and the channels become over-wide in proportion to depth. Sediment transport decreases, and there is greater deposition of sediments, especially mid-channel. Flows can become discontinuous, creating barriers to fish movement. Shallower flows can lead to increased temperatures and lower dissolved oxygen levels. Increased erosion in rivers can result in scour at restrictions such as culverts, often perching or undermining these structures so that they present barriers to aquatic organism movement and pose a threat to public safety.

Potential Strategies

Adaptation strategies should strive to integrate the protection of rivers, streams, lakes, riparian areas, floodplains, and wetlands with comprehensive land-use, watershed, and floodplain/buffer management, and targeted land acquisition. Strategies to be considered include:

1. Land Protection. Use land acquisition and conservation restrictions to target protection of vulnerable intermittent headwater streams and their buffer areas. Acquisition could be supplemented by stream easements. Well-protected headwater streams and lakes that provide high quality, cold-water flows will be integral to maintaining suitable downstream conditions during periods of warming.
2. Policy, Flexible Regulation, Planning, and Funding
   a. Facilitate streamlined permitting of aquatic habitat management projects.
   b. Develop streamflow criteria and regulations to encourage re-establishment of natural flow regimes in rivers and streams.
   c. Provide greater protections to vulnerable intermittent streams through legislation, or by encouraging local bylaws.
3. Management and Restoration
   a. Identify vulnerable river reaches, establish and protect belt-width-based river corridors, restore floodplains, and increase use of bioengineering techniques for bank stabilization.
   b. Identify and protect remaining critical coldwater fish habitat areas and seek to reconnect high quality habitats by removing in-stream barriers and re-establishing in-stream flows.
   c. Identify and implement strategies for early detection, rapid response, and prevention of invasive exotic plants and animals that out-compete native species and gradually reduce the diversity of species composition.
4. Monitoring, Research, and Adaptive Management. For aquatic system resilience, standardize monitoring protocols, improve communication with existing long-term ecological research monitoring sites, monitor pilot adaptation

strategies, and support existing monitoring networks that have a nexus with adaptation strategies.

a. Through geomorphic assessment, identify vulnerable river reaches and monitor rivers for disconnection from floodplains.

b. Update Federal Emergency Management Agency (FEMA) floodplain maps to reflect current conditions and predictions of future conditions.

Coastal Ecosystems

Seaward of the sandy beaches and rocky coastlines, beyond the salt bays and estuaries, Massachusetts' territorial waters extend three nautical miles out into the Gulf of Maine. The land under this area of open ocean is the relatively shallow continental shelf, which supports coastal ecosystems. Depths of seawater can range from 100 feet to a little more than 1,000 feet, but there are no deep trenches in Massachusetts waters.

Almost all of Massachusetts' salt waters are in estuaries and bays; very little is open ocean. Massachusetts has three great bays: Massachusetts Bay, which includes the area between Gloucester and Brant Rock, north of Plymouth; Cape Cod Bay, which includes the area from Plymouth to the tip of Cape Cod; and Buzzards Bay, extending from the Westport River near the Rhode Island border, east to the Cape Cod Canal and south to the last of the Elizabeth Islands (see "Massachusetts' Coastal Zone" map). Within the great bays are smaller bays such as Nahant Bay north of Boston, and Hull, Hingham, and Quincy bays south of Boston—all within the Massachusetts Bay.

Estuaries are affected by tidal flows and are considered brackish water, although the degree of salinity varies. Estuaries often have associated salt marsh habitat and are rich in nutrients, providing a valuable nursery for finfish, shellfish, and other macro- and micro-invertebrates, and supporting a wide range of vertebrate wildlife. These habitats are vital links in the life histories of diadromous fishes (those that spend part of their lifecycle in salt water and part in fresh water), which rely on these complex ecosystems to provide food and protection. There are estuaries all along coastal Massachusetts, but the most extensive system lies just west of Plum Island, feeding into Plum Island sound and the marshes of Essex County. A second extensive estuary system is in the Nauset Marsh/Pleasant Bay area on outer Cape Cod. Numerous shorter estuaries are along the south side of Cape Cod. The East Branch of the Westport River is one of the longest estuaries in Massachusetts.

Located between the high spring tide and mean tide levels of protected coastal shores, salt marshes and the adjacent tidal flats comprise one of the most productive ecosystems on earth. In spite of the stresses of wide variations in temperature, salinity, and degrees of inundation, the salt-tolerant vegetation of the salt marsh community provides the basis of complex food chains in both estuarine and marine environments. It also provides habitat for various species of wildlife, including migrating and overwintering waterfowl and shorebirds, and the young of many species of marine organisms. In the northeastern United States, salt marsh communities are dominated by two species of perennial, emergent grasses adapted to growth in salty soils—Saltmarsh Cordgrass and Saltmeadow Cordgrass. While these dominant species give the community a deceptively simple, grassland-like appearance, salt marsh systems are heterogeneous and provide a variety of habitats. For example, pans—the open areas in a marsh—are important to migrating waterfowl.

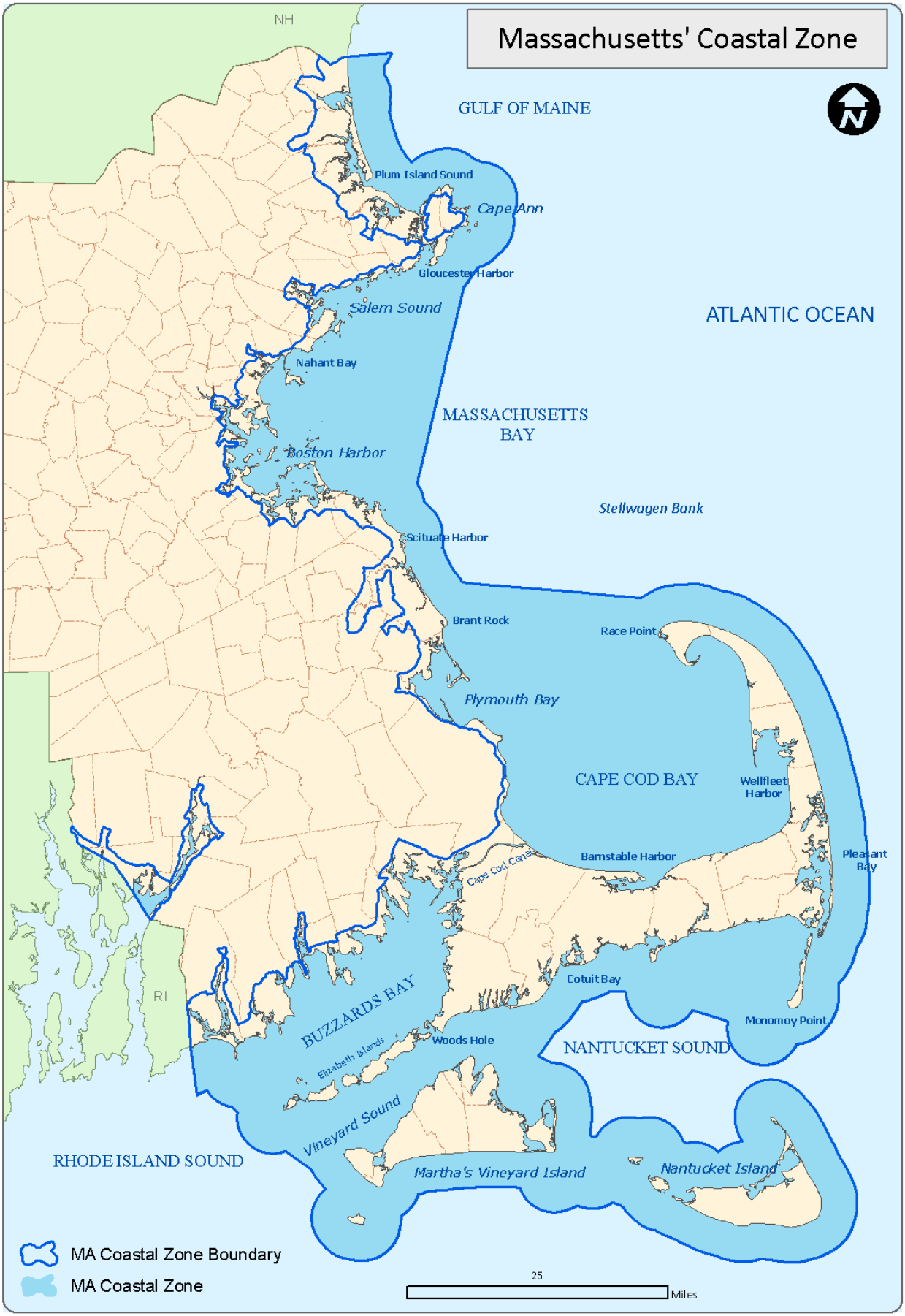
Impacts and Vulnerabilities

Coastal ecosystems will be particularly vulnerable to the impact of climate change due to the nature of their locations. In addition to responding to increased temperature, variable precipitation, and extreme weather events, sea level rise—a major climate change-related threat to Massachusetts—will expose these critical habitats to increased loss and decimation. It is anticipated that important coastal habitats will be lost and reduction of sediment load to beaches and other coastal habitats will limit the ability of these areas to maintain accretion at a rate that could match sea level rise.

Potential Strategies

A number of adaptation strategies should be explored to identify ways to mitigate potential climate change impacts to coastal ecosystems.

1. Land Protection
    a. Identify and protect undeveloped areas that are upgradient from coastal wetlands to allow wetland migration and buffer intact ecosystems; and


Massachusetts' Coastal Zone
NH
GULF OF MAINE
Plum Island Sound
Cape Ann
Gloucester Harbor
Salem Sound
ATLANTIC OCEAN
Nahant Bay
MASSACHUSETTS BAY
Boston Harbor
Stellwagen Bank
Scituate Harbor
Brant Rock
Race Point
Plymouth Bay
CAPE COD BAY
Wellfleet Harbor
Barnstable Harbor
Pleasant Bay
Cape Cod Canal
Cotuit Bay
RI
BUZZARDS BAY
Elizabeth Islands
Woods Hole
Monomoy Point
NANTUCKET SOUND
Vineyard Sound
RHODE ISLAND SOUND
Martha's Vineyard Island
Nantucket Island
MA Coastal Zone Boundary
MA Coastal Zone
25
Miles

Projected change in intertidal habitats at Parker River

The vulnerability of selected intertidal habitats in Massachusetts to climate change has been evaluated by the U.S. Fish and Wildlife Service through simulation of sea level rise at coastal Massachusetts National Wildlife Refuge sites, including the Parker River. The investigators modeled the fates of intertidal habitats using four global sea level rise scenarios. Predicted sea level rises of 0.39m (1.3 ft), 0.69m (2.3 ft), 1.0m (3.28 ft), and 1.5m (4.9 ft) by the year 2100 were superimposed on current rates of sea level rise.

At the Parker River, the extents of the intertidal habitats appear to be highly sensitive to even relatively modest sea level rise changes, with marked losses and gains occurring under the 0.39m (1.3 ft) sea level rise scenario. The habitat types that suffer greatest reductions in extent under most sea level rise scenarios are brackish marsh and tidal flats, with reductions of 50 to 99 percent. As sea level rises, intertidal land will become subtidal (hence, the increase in open water and loss of tidal flats), while saltmarsh will extend further upgradient as the inundation and salinity changes—at the expense of the brackish marshes it will replace. It is important to note, however, that the ability to move upgradient may be highly restricted by the lack of open undeveloped upland.

Projected change in intertidal habitats at Parker River

Intertidal Habitat	Current area (acres)	0.39 meter		0.69 meter		1.0 meter		1.5 meter	
		Area Change	% Change	Area Change	% Change	Area Change	% Change	Area Change	% Change
Brackish marsh	2,306	1,955	-15	1,114	-52	458	-80	3.9	-99
Salt marsh	150	423	182	1,206	704	1,715	1043	818	445
Tidal flat	803	327	-59	303	-62	382	-52	1,605	99
Estuarine open water	1,500	2,104	40	2,218	48	2,379	59	2,579	72
Ocean beach	226	264	17	266	18	261	15	22.3	-90

b. Develop high-resolution elevation models (based on LiDAR data) to identify and prioritize protection of areas that may become wetlands in the future as sea level rises.

2. Policy, Flexible Regulation, Planning, and Funding
   a. Expand use of ecological solutions to sea level rise. Hurricane Katrina dramatically illustrated the adverse consequences of removing natural ecological wetland buffers to coastal storms and relying entirely on engineered solutions. Investigate the benefits of shifting from engineering-based and infrastructure-focused solutions toward a union of engineering and ecological planning;
   b. Consider developing more flexible conservation regulations that take into account potential sea level rise and changing floodplains; and
   c. Encourage integrated community planning. Coastal habitats in Massachusetts are often areas with competing interests, stakeholders, and multiple jurisdictions. Extend planning of coastal areas beyond the state and federal agencies and involve other stakeholders to ensure representation of varied interests. (See Chapter 8 on details about assistance provided by Massachusetts Coastal Zone Management through their StormSmart Coasts program.)

3. Management and Restoration
   a. Identify, assess and mitigate existing impediments to inland migration of coastal wetlands. As sea levels continue to rise, the whole system of coastal wetlands and subtidal habitats will move inland. This cannot occur in areas where the topography does not permit it, or where barriers, such as roads, seawalls, or settlements, prevent it;
   b. Identify and assess potential restoration of coastal wetlands. Sea level rise destroys habitats since the rate of rise exceeds the rate at which wetland soils are replenished by sediments. It may be possible at some sites to mitigate this and preserve the wetlands;

c. Manage the spread of invasive species. Support efforts to reduce nutrient loading of waterways and waterbodies.

4. Monitoring, Research, and Adaptive Management. Track the movement of tidal resources as they respond to sea level rise using on-the-ground sensing (e.g., more tide gauges), and remote sensing (e.g., increased regular photo coverage of vulnerable areas). Integrate this information into management plans so that decision-makers are alerted when management thresholds that trigger new policies are reached.

Wetland Ecosystems

Wetlands have always been an important feature of the Massachusetts landscape. Common wetland types include wooded deciduous swamps, emergent wetlands, wet meadows, bogs, and vernal pools. As Massachusetts is a coastal state and one of the most densely populated states in the country, development pressures, and accompanying wetland losses, are a reality. It has been estimated that, by the mid-1980s, Massachusetts had lost approximately 28 percent of its estimated original wetland base. More recent data suggest that about 1700 acres (approximately 0.2 percent) changed during the period from the mid 1990s to present (MassDEP, 2011). Activities causing the most loss are residential development, commercial development, sand and gravel operations, and agriculture. Of these losses, wooded deciduous swamps are the most highly impacted.

Existing Resources

For purposes of this document, wetlands in this chapter refer to freshwater wetlands such as shrub and forested swamps, emergent marshes, bogs and fens, vernal pools, and related ecosystems. Shrub swamps are shrub-dominated wetlands occurring on mineral or mucky mineral soils that are seasonally or temporarily flooded or saturated. They often occur as successional areas between freshwater marsh and forested swamp (Mitsch & Gosselink, 2007) and occur in association with other wetland types in wetland complexes.

Forested swamps, the most abundant type of all wetlands in the northeastern United States (Golet et al., 1993), are wetlands where trees dominate the vegetation and there is generally little buildup of peat. They usually occur as patches within the surrounding upland matrix forest. In the warmer southern and eastern sections of the state and in the central hardwood area, forested swamps are dominated by red maple or Atlantic white cedar.

Bogs are among the best-known peatlands and generally have the thickest peat deposits. Bog communities receive little or no streamflow and they are isolated from the water table, making them the most acidic and nutrient-poor of peatland communities. Several of the state's listed rare animal species are found in bogs. Marshes and wet meadows are some of the most important inland habitats for many species of animals, both rare and common.

Vernal pools are relatively common, with some 30,000 statewide. These are ephemeral wetlands that fill annually, mainly in the spring, from precipitation, runoff, and rising groundwater. In most years, they become completely dry later in the season, losing their water to evaporation and transpiration over the summer. This wet-dry cycle prevents fish from becoming established permanently and presents an important fish-free, if temporary, breeding habitat for many species.

Impacts and Vulnerabilities

Changes in the timing, frequency, and duration of precipitation and increases in flooding will cause changes in water depths, hydroperiods, and flow dynamics. Loss of snow and ice will result in a loss of ice-related structural changes to banks and floodplains. If reduced precipitation and increased drought occur during the season when animals breed and develop in vernal pools, then the length of time that vernal pools hold water could be reduced, potentially leading to a reduction in vernal pool populations.

With increased temperatures, species and wetland types that are more typical of cooler and/or higher northern areas (such as northern bogs, spruce-fir boreal swamps, hemlocks) may be reduced or disappear. Wetlands dominated by conifers usually found in cool conditions may become more deciduous, changing their biogeochemistry and potentially the entire wetland habitat. Southern species, including invasives and pests, could move

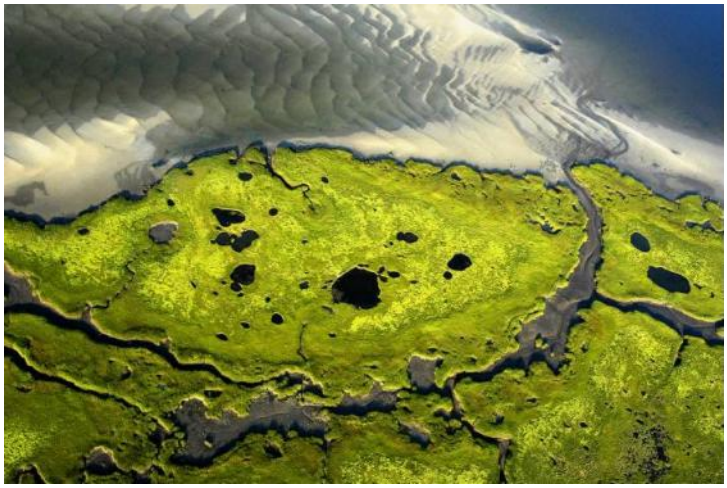
northward or expand their presence in locations that are currently at the northern edge of their range and could stress some native species. Native New England species and populations may become less competitive relative to southern species/populations when the growing season lengthens and temperatures warm.

Increased temperatures can also dry the peat wetland soils, resulting in oxidation and release of stored organic carbon to the atmosphere and changes in pH. Wetland soils may lose saturation. The surface can become less absorptive and more prone to scour, erosion, and runoff, thus reducing groundwater recharge and storage function. Higher temperatures may also cause reduction or loss of isolated vegetated wetlands and drier or transitional fringes of bordering vegetated wetlands. Reductions in regulated wetland size might be temporary or permanent, depending on overall climatic changes. In some cases, former wetlands would no longer be regulated and would be treated as uplands, but would have the potential to return to wetland status and function during wetter times and, therefore, continue to provide crucial buffering capability to upland developed areas.

Potential Strategies

Various adaptation strategies should be investigated as ways to mitigate potential climate change impacts to wetland ecosystems.

1. Land Protection
   a. Identify and protect resilient wetland ecosystems. Focus land protection on areas with high ecological integrity and resiliency over time. Priority areas include large undeveloped blocks of habitat that contain diverse wetland complexes, large wetland systems, and intact riverine systems with abundant associated wetlands.
   b. Identify and prioritize protection of migration corridors between wetland areas and between wetlands and the associated upland habitat including large resilient parcels connected by migration corridors. Planning should include both aquatic and terrestrial connectivity.
   c. Preserve and acquire buffer zones. Buffer zone protection should incorporate predictions for wetland resource and ecological migration resulting from climate changes.
   d. Use LiDAR and other data to identify important wetlands and ensure that a variety of wetland types is represented in land protection planning.
   e. Protect the natural hydrologic function of wetlands with large peat deposits. When peat deposits are exposed to oxygen, they release stored carbon. Preventing the release of carbon stored in peat provides climate change mitigation.
2. Policy, Flexible Regulation, Planning, and Funding
   a. Develop flexible and climate-responsive regulations to support ecological adaptation and resilience.
   b. Survey wetlands across the state to identify vulnerable reaches.
   c. Encourage the passage of bylaws and use of other tools to strengthen protection of isolated vegetated wetlands that are most vulnerable to climate change. Consider revising the Massachusetts Department of Environmental Protection (DEP) "Handbook for Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act" to include flexible wetland delineation criteria for use when drought and below-normal precipitation conditions are observed in the field. Review U.S. Army Corps of Engineers Draft Interim Wetland Delineation Manual for applicability in Massachusetts.
   d. Explore strategies to improve protection of buffer zones around vulnerable wetlands and vernal pools.
   e. Promote restoration of floodplains.
   f. Consider climate change when evaluating development in vulnerable wetland and floodplain areas.
   g. Consider changes to the 401 Water Quality Certification Regulations to address vulnerable isolated vegetated wetlands.



3. Management and Restoration
   a. Develop flexible and climate-responsive management strategies to support ecological adaptation and resilience.
   b. Coordinate and share information with other states in the Northeast, and maximize coordination between state agencies and between state and local government and federal agencies.
   c. Promote riparian zone and floodplain management, restoration and preservation by removing restrictions between rivers and floodplains, daylighting streams, removing dams, and integrating brownfields remediation projects with floodplain restoration.
   d. Encourage application of geotextiles and bioengineering techniques for erosion control and stream stability. Discourage traditional engineering solutions to flood control such as berms, channelization, channel widening, and armoring of banks.
4. Monitoring, Research, and Adaptive Management
   a. Monitor different types of wetlands. Establish long-term research and monitoring sites.
   b. Support research on adaptive strategies and pilot projects.
   c. Prepare and distribute a wetlands, waterways/ waterbodies and climate change adaptation best management practices handbook.
   d. Consolidate existing MassGIS and Natural Resources Conservation Services soils mapping that identify peat deposits in Massachusetts, and utilize as a planning tool for management of soil carbon stores.

Conclusion

Analysis across habitat categories yielded several similar broad principles for potential adaptation strategies. These were grouped in four categories: Land and Water Protection; Land and Water Management and Restoration; Policy, Flexible Regulation, Planning and Funding; and Monitoring, Research, and the Effective Use of Adaptive Management Techniques. Although strategies are specific to habitat categories, the commonalities across habitats were striking. Many recommended strategies reflect ongoing initiatives that require refocusing and enhancements to incorporate climate change as a factor in decision-making. For example, the land acquisition process at DFG, which already considers habitat connectivity and occurrence of unfragmented interior forest blocks, was recently re-adjusted to also consider climate change as a factor. Land acquisition at EEA and its other agencies is also undergoing a similar effort. Results from the Climate Change and Massachusetts Fish and Wildlife reports will be used to inform implementation strategies of the State Wildlife Action Plan—the major guidance document for decision-making relative to wildlife and habitat management.

This chapter identifies forests, wetlands, rivers, and streams as critical habitats with an array of functions that may be affected by climate change. Protecting these ecosystems, and their functions, will be a crucial step in helping natural systems and human communities cope with climate change. It will be important to develop a flexible regulatory approach that will allow time-sensitive responses to threats, and development of flexible wetland definitions that reflect on-the-ground realities. One of the greatest challenges identified in this chapter is the need to develop an efficient monitoring program that informs an adaptive management decision framework.

 The symbol signifies adaptation strategies that are also climate change mitigation actions.

REFERENCES

Alerich, C. L., 2000. Forest statistics for Massachusetts: 1985 and 1998. Resour. Bull. NE-148. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station, p.104.

American Forest and Paper Association, 2011. http://www.afandpa.org/State_Brochures/Massachusetts.pdf.

Beier P., and B. Brost, 2010. Use of Land Facets to Plan for Climate Change: Conserving the Arenas, Not the Actors. Cons. Bio.

BioMap: Guiding Land Conservation for Biodiversity in Massachusetts, 2001. Massachusetts Executive Office of Environmental Affairs.

Biomap2: Conserving the Biodiversity of Massachusetts in a Changing World, 2010. http://www.mass.gov/dfwele/dfw/nhesp/land_protection/biomap/biomap_home.htm.

Campbell, S. M., 2000. Quantifying Public Benefits on Private Forestland in Massachusetts. Massachusetts Forest Stewardship Program's Task Force on Reforming Forest Taxation.

D'Amato, A.W., and P. Catanzaro, 2007. Restoring old-growth characteristics. University of Massachusetts, Cooperative Extension Landowner Outreach Pamphlet. http://www.forestry.umn.edu/silviclab/PUBLICATIONS/old%20growth.pdf.

Foster, D. R., J. D. D. Aber, J. M. Melillo, R. D. Bowden, and F. A. Bazzaz, 1997. Forest response to disturbance and anthropogenic stress. BioScience 47(7): 437-445.

Gibbs, J. P., and A. R. Breisch, 2001. Climate warming and calling phenology of frogs near Ithaca, New York, 1900-1999. Conservation Biology 15, 1175-1178.

Glick, P., A. Staudt, and B. Stein, 2009. A New Era for Conservation: Review of Climate Change Adaptation Literature. National Wildlife Federation, Reston, VA.

Golet, F. C., A. J. K. Calhoun, W. R. DeRagon, D. J. Lowry, and A. J. Gold, 1993. Ecology of red maple swamps in the glaciated northeast: a community profile. U.S. Department of the Interior, Fish and Wildlife Service, Biological Report 12, Washington, D.C.

Heller, N. E., and E. S. Zavaleta, 2009. Biodiversity management in the face of climate change: A review of 22 years of recommendations. Biological Conservation 142: 14-32.

Juanes, F., S. Gephard, K. F. Beland, 2004. Long-term changes in migration timing of adult Atlantic salmon (Salmo salar) at the southern edge of the species distribution. Cdn. J. Fisheries and Aquatic Sciences 61: 2392-2400.

Keeton, W. S., 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. Forest Ecology and Management 235 (2006) 129–142.

Living Waters: Guiding Land Protection of Freshwater Biodiversity in Massachusetts, 2003. Massachusetts Executive Office of Environmental Affairs.

Massachusetts Department of Environmental Protection, 2011. Wetland Mapping Program Project.

MassGIS, Department of Environmental Protecion wetlands datalayer.

Mawdsley, J. R., R. O'Malley, and D. S. Ojima, 2009. A Review of Climate-Change Adaptation Strategies for Wildlife Management and Biodiversity Conservation. Conservation Biology 23: 1080–1089

Mitsch, W. J., and J. G. Gosselink, 2007. Wetlands. John Wiley & Sons, Inc.

Ramsar, 2002. http://www.ramsar.org/pdf/cop8/cop8_doc_11_e.pdf.

Swain, P. C., and J. B. Kearsley, 2001. Classification of the Natural Communities of Massachusetts. Version 1.3. Natural Heritage & Endangered Species Program, Division of Fisheries & Wildlife, Westborough, MA.

TEEB, 2009. The Economics of Ecosystems and Biodiversity for national and international Policy Makers. http://www.teebweb.org/.

U.S. Environmental Protection Agency, 2008. Effects of climate change for aquatic invasive species and

implications for management and research. National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/014. Available from the National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea.

Wolfe, D. W., M. D. Schwartz, A. Lakso, Y. Otsuki, R. Pool, and N. Shaulis, 2005. Climate change and shifts in spring phenology of three horticultural woody perennials in northeastern USA. Internat. J. Biometeor. 49: 303-309.

Other Useful References

Department of Conservation and Recreation, District Forest Management Plans: http://www.mass.gov/dcr/stewardship/forestry/manage/planning.htm.

Executive Office of Energy and Environmental Affairs, Forest Reserve Management: http://www.mass.gov/?pageID=eoeeasubtopic&L=4&L0=Home&L1=Agriculture%2c+Forestry%2c+Fishing+%26+Hunting&L2=Sustainable+Forest+Management&L3=Forest+Reserves&sid=Eoeea.

Fahey, T. J., P. B. Woodbury, J. J. Battles, C. L. Goodale, S. Hamburg, S. Ollinger, and C. W. Woodall, 2009. Forest carbon storage: ecology, management, and policy. Frontiers in ecology and the Environment. doi: 10.1890/080169

Hansen, L., J. Biringer, and J. Hoffman, 2003. Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems. WWF. http://www.worldwildlife.org/climate/Publications/WWFBinaryitem4922.pdf.

Hayhoe, K., C. P. Wake, T. G. Huntington, L. Luo, M. D. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. Degaetano, T. J. Troy, and D. Wolfe, 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Climate Dynamics 28:381-407, DOI 10.1007. Online at: www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

Massachusetts Comprehensive Wildlife Conservation Strategy, 2005. Massachusetts Executive Office of Environmental Affairs.

NECIA. 2006. Climate Change in the U.S. Northeast. A report of the Northeast Climate Impacts Assessment. Union of Concerned Scientists, Cambridge, MA.

Ollinger, S. V., J. D. Aber, P. B. Reich, and R. J. Freuder, 2002. Interactive effects of nitrogen deposition, tropospheric ozone, elevated CO2 and land use history on the carbon dynamics of northern hardwood forests. Global Change Biology (8) 545-562.

Swain, P. C., and J. B. Kearsley, 2000. Classification of the Natural Communities of Massachusetts. Massachusetts Division of Fish and Wildlife, Westborough, MA.

Urbanski, S., C. Barford, S. Wofsy, C. Kucharik, E. Pyle, J. Budney, K. McKain, D. Fitzjarrald, M. Czikowsky, and J. W. Munger, 2007. Factors controlling CO2 exchange on timescales from hourly to decadal at Harvard Forest. Journ. of Geophysical Research, 112, G02020, doi:10.1029/2006JG000293.

Case Studies

Terrestrial Invasive Species—The Hemlock Woolly Adelgid:

- http://www.saveourhemlocks.org/you_can_help.shtml
- http://www.wickedlocal.com/weston/homepage/x124631854/Update-on-Hemlock-Woolly-Adelgid
- http://www.sciencedaily.com/releases/2009/02/090226122730.htm
- http://www.hemlockgorge.org/FHG_Adelgid_Archive/FHGAdelgidNewsStoriesArchive.htm
- http://www.boston.com/news/nation/articles/2007/06/10/as_ne_warms_tiny_pests_take_root/

Projected change in intertidal habitats at Parker River:

Clough, J. S., and E. C. Larson, 2009. Application of the Sea-Level Affecting Marshes Model (SLAMM 5.0) to Parker River NWR. Prepared by Warren Pinnacle Consulting, Inc. for: Dr. Brian Czech, Conservation Biologist, U. S. Fish and Wildlife Service, National Wildlife Refuge System, Division of Natural Resources and Conservation Planning.

5 — Key Infrastructure

SUBCOMMITTEE CHAIRS:

	Edward Kunce	Department of Environmental Protection (DEP)
	Ronald Killian	Department of Transportation (MassDOT)

ADVISORY COMMITTEE PARTICIPANTS:

Donald Boyce	Massachusetts Emergency Management Agency (MEMA)
Marc Draisen	Metropolitan Area Planning Council
Raymond Jack	Massachusetts Water Works Association
Paul Kirshen	Batelle Memorial Institute
Arthur Marin	Northeast States for Coordinated Air Use Management
Bernie McHugh	Massachusetts Land Trust Coalition
William Moomaw	The Fletcher School, Tufts University
Angela O'Connor	New England Power Generators Association
Jeffrey Reade	AECOM
Alexander Taft	National Grid
Peter Weiskel	U.S. Geological Survey
Norman Willard	U.S. Environmental Protection Agency
Robert Zimmerman	Charles River Watershed Association

OTHER CONTRIBUTING MEMBERS:

Kathleen Baskin	Executive Office of Energy and Environmental Affairs
Susan Beede	Massachusetts Rivers Alliance
Victoria Bonanno	Department of Transportation
Brian Brodeur	Department of Environmental Protection
Arietta Chakos	Harvard Kennedy School
Stewart Dalzell	Massachusetts Port Authority
Heidi Davis	Department of Environmental Protection
Hope Davis	Division of Capital Asset Management
Paul Emond	Department of Environmental Protection
Mary Emerson	Northeast Utilities
Stephen Estes-Smargiassi	Mass. Water Resources Authority
John Felix	Department of Environmental Protection
David Ferris	Department of Environmental Protection
Christian Jacqz	MassGIS
Alex Kasprak	Department of Transportation
Julia Knisel	Office of Coastal Zone Management
Steve Leahy	Northeast Gas Association
Paul Lopes	Department of Energy Resources
Marcos Luna	Salem State College
Joanne McBrien	Department of Energy Resources
Elizabeth McCann	Department of Environmental Protection
Donald McGough	City of Boston
Steven Miller	Department of Transportation
Mike Misslin	Department of Conservation and Recreation
Madelyn Morris	Department of Environmental Protection
Richard Murphy	Department of Transportation
Daniel Nvule	Mass. Water Resources Authority
Thomas O'Rourke	NSTAR
Luisa Paiewonsky	Department of Transportation
Holly Palmgren	Massachusetts Bay Transportation Authority
James Paterson	Department of Environmental Protection
Vandana Rao	Executive Office of Energy and Environmental Affairs
John Read	Boston Redevelopment Authority
Griffin Ryder	Vanasse Hangen Brustlin, Inc.
Chris Sherman	Formerly with New England Power Generators Association
Jessica Stanley	Department of Environmental Protection
Brad Swing	City of Boston
David Terry	Department of Environmental Protection
Sarah White	Mass. Emergency Management Agency
Jacki Wilkins	Massachusetts Port Authority
Catrice Williams	Department of Telecommunications and Cable
Stanley Wood	Department of Transportation
Beverly Woods	Northern Middlesex Council of Governments
Jonathan Yeo	Department of Conservation and Recreation
Richard Zingarelli	Department of Conservation and Recreation
Steven Zuretti	New England Power Generators Association

INTERNS:

Cassandra Snow, Victoria Wolff, Kira Sargent

5 Key Infrastructure

Introduction

A society cannot function without well-maintained infrastructure that provides critical services for its citizens. These services include providing habitable residential and workspace, transportation, energy sources, telecommunications, clean water, health, and safety, as well as systems to control such infrastructure threats as flooding, and improper release or disposal of wastewater, solid waste, and hazardous materials.

Since the Industrial Revolution, significant infrastructure development in Massachusetts has occurred along the coastline, major rivers, and in floodplains. This trend, along with other urban growth patterns, placed much of Massachusetts' key infrastructure resources in areas that are predicted to experience adverse effects from climate change.

A compounding factor is that most, if not all, of the key infrastructure resources were sited and designed based on historic weather, sea level, and flooding patterns. Climate change impacts are predicted to result in significant changes to these variables, making many infrastructure assets in Massachusetts vulnerable to future damage. It is expected that increased frequency of extreme weather events, combined with sea level rise, will considerably raise the risk of damage to transportation systems, energy -related facilities, communication systems, a wide range of structures and buildings, solid and hazardous waste facilities, and water supply and wastewater management systems. Consequential changes in precipitation patterns, particularly from extreme weather events, will threaten key infrastructure assets with flood and water damage.

The seven main infrastructure sectors analyzed in this chapter are listed in Table 4.

Overview of Vulnerabilities

Predicted climate change impacts have the potential to damage or destroy key infrastructure throughout Massachusetts. A problem common to infrastructure design is that planners, engineers, and designers traditionally have used historic weather characteristics to determine the weather conditions that infrastructure assets can withstand. Since future climate patterns are expected to be different, designs based on historic weather patterns could leave infrastructure at risk.

Predicted climate change impacts—in particular, sea level rise and more numerous extreme storm events —have the potential to impair public and private services and business operations. A substantial rise in sea level, even during calm weather, will cause flooding of buildings, roadways, tunnels, water and wastewater treatment facilities, and equipment and instruments associated with power stations and telecommunication facilities. Solid waste landfills and hazardous waste sites located in low lying coastal areas also will be vulnerable. In addition, saltwater intrusion into freshwater aquifers located near the

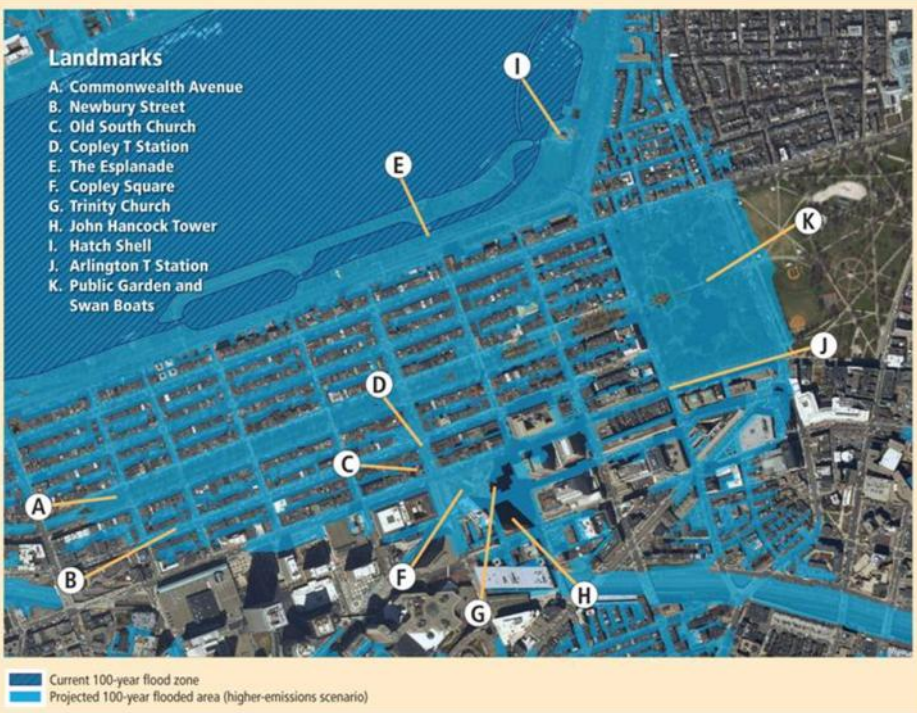
SECTOR	INFRASTRUCTURE INVOLVED
Energy (electric, gas, petroleum)	Production, transmission, storage, and distribution including power plants, substations, electric lines, natural gas systems, and fuel systems
Transportation (land, sea, air)	Roads, highways, bridges, tunnels, subway, commuter and commercial rail, ferries, buses, airports, and ports
Water (supply, wastewater, stormwater)	Water sources, pump stations, storage tanks or reservoirs, distribution systems, drinking water treatment, municipal separate storm sewer systems, combined wastewater and stormwater systems, decentralized stormwater management systems, and septic systems
Dam Safety and Flood Control	Dams, dikes, and land levees
Solid and Hazardous Waste	Solid waste facilities and hazardous waste storage and management facilities
Built Infrastructure and Buildings	Commercial, residential, industrial, institutional, and governmental buildings
Telecommunications	Phone, internet, and cable

Table 4. ***Key infrastructure sectors vulnerable to climate change impacts***

coastline will compromise coastal drinking water sources.

Sea level rise will expose infrastructure to storm surges and shift the current 100-year coastal storm floodplain and velocity zone landward to cover much of the Back Bay and Boston waterfront areas, for example. Some of the state's most significant infrastructure—including the Massachusetts Port Authority's Logan International Airport and port/ maritime facilities, the Massachusetts Water Resources Authority's (MWRA) Deer Island Sewage Treatment Plant, and highway and public transit tunnels—are located in these areas.

The expected increases in intensity and frequency of extreme storm events could severely impact infrastructure, damage public and private services, and negatively impact business operations throughout the state. High winds and flooding along rivers and streams have incapacitated both inland and coastal communities during large storm events such as the Blizzard of '78, the Mother's Day Storm of 2006, the Ice Storm of December 2008, and to some extent the recent Tropical Storm Irene (2011). In the past, such storms have been relatively infrequent and services have been restored relatively quickly. Occasionally much larger storms, such as the Hurricane of 1938, Hurricane Carol (1953), and Hurricane Donna (1960), have caused extensive devastation throughout Massachusetts. With more frequent large storm events, damage to key infrastructure could become more frequent, take longer to repair, and entail more costly repairs and economic disruption.



General Strategies

Preparing for future climate change impacts will take a coordinated effort of private and public sectors, non-profit organizations, and managers and users of infrastructure resources. Primary strategies should promote actions that will bolster infrastructure resources to defend them against these impacts while simultaneously supporting other sectors' strategies,and promoting due diligence and sound management decision-making. These include:

1. Accurate Mapping and Surveys: Update floodplain mapping using new LiDAR elevation surveys and climate models to identify at-risk facilities and natural features, and establish action priorities with cost estimates. Conduct comprehensive LiDAR mapping of the Massachusetts coast, shoreline waterways, and other flood-prone land areas and facilities, complemented by a detailed three-dimensional survey of individual at-risk facilities to determine vulnerabilities, most cost-effective strategies (defend or retreat), and action time frames.

2. No Regrets Actions: These measures will bolster infrastructure resources for future climate change impacts and improve other related efforts. They could also be actions that reduce greenhouse gas emissions and save future investments and valuable resources. Examples include:

•conservation, efficiencies, and reuse of key resources, such as drinking water conservation and improved stormwater management,

which will provide capacity and resilience for many key infrastructures to withstand climate change impacts;
- cost-effective and simple improvements, such as flood-proofing structures, which can be made during routine maintenance and upgrading.

3. Explore Possible Changes in Land Use, Design, Site Selection, and Building Standards: Investigate amendments to existing land use planning and zoning laws and regulations and building codes to account for expected climate change impacts when designing and constructing new infrastructure, repairing and upgrading existing infrastructure, and evaluating sites and areas suitable for infrastructure development. Bolster ongoing efforts by state agencies to factor climate change into future design, permitting, and building requirements. These land use, siting, design, and building standards should be reviewed on a routine basis to integrate new knowledge on predicted climate change impacts.
4. Enhance Natural Systems: Provide protection and resilience of infrastructure to climate change impacts by enhancing natural systems such as restoring wetlands, coastal features, and flood storage capacity. Restore the natural hydraulic features of watersheds to increase resiliency and capacity redundancy in wastewater systems, water supplies, and stormwater management resources.
5. Identify Lead Times for Adaptive Construction: Since different types of facilities have varying life spans, translate those timeframes into lead times for infrastructure replacement and rehabilitation. Energy infrastructure that has a lifespan of 30 years will have a different adaptation strategy than a power plant that may have a 50- to 60-year lifespan. The amount of time needed to permit, repair, improve, or build infrastructure will vary and should be identified.

The remainder of this chapter examines the vulnerability of various infrastructure sectors to climate change impacts and outlines no regret, short -term, and long-term strategies that will continue to be reviewed and considered for implementation regionally or statewide.

Energy

Without reliable energy services, the basic needs of residents, visitors, businesses, and governments cannot be met. Lost or damaged energy supplies would cause loss of power to homes, schools, government buildings, hospitals, industries, and businesses, as well as to various types of infrastructure, such as communications systems, which depend on energy to function.

Existing Resources

The electric power infrastructure is an interconnected system of power plants, substations, and hundreds of miles of high voltage transmission lines and local distribution wires. There are approximately 170 electric generating facilities throughout Massachusetts, ranging in size from less than one to hundreds of megawatts (MW). Several of the largest plants are located along the coast. The fuel used by generators to create electricity is diverse—natural gas, coal, oil, nuclear, and renewable sources such as solar, wind, hydro, and biomass. Massachusetts annually consumes about 56 million megawatt-hours (MWh) of electricity representing 46 percent of New England's total consumption (U.S. Department of Energy, 2008). ISO New England reports that, in 2008, the Greater Boston area consumed about 40 percent of the state's electricity. A large share of the electricity is generated in-state, but Massachusetts also relies on electricity from neighboring states.

Massachusetts is the largest consumer of natural gas in New England. The US Census Bureau reported that gas is the state's largest energy source for home fuel (about 44 percent), and ISO New England notes that natural gas is also the leading energy source for electricity generation in New England as a whole (38 percent). Massachusetts receives its gas supplies via three interstate pipeline systems and via liquefied natural gas (LNG) tanker ships. Massachusetts has three liquefied natural gas import terminals. One is located on land in Boston Harbor and the other two are located 11 to 13 miles offshore. Ships connect to buoys at the offshore terminals, the LNG is gasified, and then it is transported via undersea pipelines. Gas is delivered to customers through 1,000 miles of underground transmission pipes and 21,000 miles of local distribution pipes.

Massachusetts is dependent on petroleum product imports from domestic and foreign sources. There are five major petroleum terminals along Boston

Harbor waterways and smaller terminals in other coastal communities. Almost 90 percent of the petroleum products are imported into the state by ship or barge. To reach inland regions such as western Massachusetts, petroleum is transported via trucks from in-state and out-of-state terminals. The oil terminals in Springfield receive petroleum via local underground pipelines fed from ships in New Haven, CT, and Providence, RI.

Impacts and Vulnerabilities

To assess climate-induced changes and impacts for this sector, assets were identified and organized into three broad subcategories: 1) facilities, including electric generation plants (nuclear, natural gas, oil, and coal), LNG terminals, propane plants, petroleum product terminals and storage facilities, and electric substations; 2) above-ground wires and pipes; and 3) below-ground wires and pipes.

The energy sector's three primary climate change concerns are flooding (due to increased precipitation and storm surge), extreme events (such as hurricanes and snow and ice storms), and increased temperature. These events can affect almost all infrastructure assets. In addition, climate change impacts that affect energy producing regions beyond Massachusetts' borders, such as the Gulf Coast, could cause greater frequency and severity of energy supply interruptions for Massachusetts.

The following are the predicted impacts on energy infrastructure:

- Extreme and more frequent weather events, including flooding, may damage energy production and delivery equipment such as generation plants (e.g. the Pilgrim nuclear power station), terminals, storage facilities and above- and below-ground wires and pipes. Damaged infrastructure will lead to interrupted service, degraded energy reliability, increased equipment maintenance or replacement costs, and adverse impacts to public safety.
- Sea level rise and storm-related flooding may require relocating coastal infrastructure, which would require new real estate acquisitions for replacement sites.
- Extreme temperature changes could result in an increased demand for cooling in summer and a decreased demand for heating in winter. One 2005 study of changes in Boston's heating and cooling demand indicates that, "depending on the climate scenario, household electricity consumption in peak summer months may be nearly three times that of the 1960-2000 average, with over 25 percent of the increase directly attributable to climate change" (Amato et al., 2005). Such changes also can shift energy production and use. For example, high temperatures reduce thermal efficiency of electric generation. This could challenge the ability of the electric system operators to meet peak electricity demands.
- There may be lengthened repair times and delays. Repair crews will find it more difficult to work in protective gear for extended periods in high temperatures, during prolonged rain or in extreme cold.

Potential Strategies

No Regrets Strategies

1. Encourage Energy Efficiency. Energy efficiency is both a mitigation and an adaptation strategy. Decreased energy demand defers the need for additional infrastructure and helps to avoid peak load outages.

Impacts of the Ice Storm of December 2008

From December 11 through December 18, 2008, central, western, and northern Massachusetts experienced a severe ice storm, which caused devastation over almost 7,000 square miles. The storm damage affected the energy and transportation infrastructure, homes and schools, and even the Appalachian Trail. Over one million customers were impacted by power outages with over 550,000 customers losing their electricity at the peak of the storm, and some for up to two weeks. This also caused additional damage, such as frozen water pipes in commercial and residential properties, as well as lost revenue. Countless trees were damaged, with downed trees and tree limbs blocking roads, damaging property and bringing down power lines.

The storm was very costly—the Federal Emergency Management Agency (FEMA) obligated over $32 million for reimbursement to seven Massachusetts counties for eligible costs; state costs exceeded $7 million and municipalities expended over $5 million. National Grid, one of the primary electrical suppliers in the area, claimed over $30 million in storm-related costs.

2. Educate Asset Owners and Regulators. Regulators, energy asset owners, and privately- and municipally-owned utilities should understand the future impacts of climate change on infrastructure and the benefits and costs associated with preparing for and responding to climate change.
3. Diversify Energy Supplies. To avoid reliance on supply from one geographical region that may be more vulnerable to climate change, utilities and other energy suppliers should continue to assess the diversification of their energy supply portfolios and factor in future climate change predictions.
4. Track Trends in Energy Demand, taking into account climate change forecasts. Regulators, energy asset owners, and privately- and municipally-owned utilities should carefully track changes in energy demand resulting from climate change and factor such changes into future planning and procurement strategies.
5. Plan for Changes in Consumers' Expectations Regarding Energy Types. Consumers have altered their perceptions about climate change. As a result, more consumers are requesting energy supplies from cleaner energy sources. Closely monitor consumer trends to anticipate the types of energy supplies that will be in demand, such as renewable energy and emerging biofuels, and the potential impacts that climate change will have on these new sources.

Short-Term Strategies

1. Utilize and Accelerate Deployment of New Energy Efficiency Technologies. Smart Grid technology may stabilize load requirements during high demand periods, thus ensuring supply and system integrity as well as increasing power reliability during storms, flooding, or high peak load.

A **Smart Grid** is a network for electricity transmission and distribution systems that uses two-way, state-of-the-art communications, advanced sensors and specialized computers to improve the efficiency, reliability, and safety of electricity delivery and use.

2. Encourage Research and Development of Renewable Energy Technologies. Renewable energy technologies such as solar, wind, tidal and wave power, and other emerging renewable applications are new and growing sources of electricity supply and jobs. They will diversify our electricity generation portfolio and reduce pollution.
   - Wind: Climate change (temperature, precipitation, humidity, solar) may lead to changing wind patterns. Design wind turbines to meet low-medium-high wind speeds. Monitor onshore, nearshore, and offshore wind patterns to determine optimal siting locations.
   - Solar: With enhanced monitoring and preparation, Massachusetts can rapidly protect its growing solar electric capacity from severe weather impacts, including panel degradation. Careful monitoring of the Massachusetts climate and better predictions will be necessary to determine the proper specifications of future photovoltaic investments.
3. Consider Undertaking a Regional Analysis of New England's Integrated Energy Infrastructure. Analyze climate change effects on interstate energy infrastructure. The New England states, along with the electric Independent System Operator of New England (ISO New England), and gas and oil industry representatives, should work together to develop a comprehensive regional analysis of climate change impacts on supply and demand as well as storm response.

Long-Term Strategies

1. Collaborate with other states and utilities to ensure the best-integrated strategies are deployed, particularly given the size of capital and operational investments in utilities infrastructure, and support facilities with long life -spans.
2. Utilities should work with land use planners at the state environmental and regulatory levels to secure necessary parcels to meet the need for energy infrastructure that is threatened by flooding, extreme storm events, and increased temperature.

Transportation

The Massachusetts transportation system is vitally important to the daily functioning and economic future of the state. The transportation sectors outlined in Table 5 and their respective infrastructure ensure economic vitality and quality of life by safely and efficiently moving people, goods, and services throughout the state.

Existing Resources

To appreciate the breadth and depth of our reliance on a diverse transportation network, Table 5 outlines the basic elements of the state's road and rail network and other transportation infrastructure.

Impacts and Vulnerabilities

The impact to the various forms of transportation, particularly along the coast, could dramatically affect the ability to sustain normal levels of commerce, public health, safety, welfare, and security, and to respond to natural or human-induced severe events. Coastal transportation infrastructure is most vulnerable to sea level rise and extreme weather events including high winds, waves, and storm surge. High temperatures and dense air conditions could increase runway length requirements to accommodate typically diminished aircraft performance in such weather situations.

Inland infrastructure also may be affected by changing precipitation patterns, extreme weather events, and increased temperatures. Massachusetts may not have sufficient alternative transportation modes and routes available in particularly sensitive locations to provide backup and continuity of service in responding to climate change effects.

Potential Strategies

No Regrets Strategies

1. Continue Maintenance of Existing Infrastructure. Maintain existing transportation infrastructure to minimize the chances of flooding or other damage that might occur before final or more permanent adaptation plans can be implemented.

TRANSPORTATION RESOURCE HIGHLIGHTS*	
ROADS	71,887 lane miles (60,970 local lane miles at 85 percent, 10,917 state lane miles at 15 percent) 5,116 inventoried bridges (3,550 state, 1,566 municipal) Vast majority of total freight in Massachusetts moves by truck ($307 billion commodity value, 196 million tons)
RAIL	438 million Massachusetts Bay Transportation Authority (MBTA) passengers per year, or 1.2 million passengers per day (5th highest transit ridership in U.S.) 175 cities and towns, with a total population of 4.7 million people, serviced by the MBTA 2,500 vehicles, 258 stations, 885 miles of track, 500 bridges, 20 miles of tunnels, 19 maintenance shops 2.65 million Amtrak riders per year (Boston's South Station is Amtrak's 6th busiest station in U.S.) Commercial rail traffic: 14 carriers carry about 500,000 rail carloads per year over 1,000 miles of track
AIR	The 39 public-use airports handled about 2.1 million operations (takeoffs & landings) and 26.0 million passengers in 2009. Of those totals, Logan Airport accommodated 345,300 operations and over 25.5 million passengers The other 38 public-use airports accounted for 1.75 million operations and 476,000 passengers Logan Airport managed 191.1 million pounds of cargo, 28.8 million pounds of mail, and 326.5 million pounds of express/small packages in 2009 198 private landing areas: 112 helipads, 47 landing strips/airfields, 38 seaplane bases, and one military landing strip
BUS	29 million passengers per year use 1,372 buses and vans provided by 15 Regional Transit Authorities MBTA operates 1,055 buses on 186 routes over 761 route-miles; THE RIDE, a paratransit service, operates 568 vehicles in 62 municipalities and averages over 1.58 million trips per year Boston's South Station provided about 190,000 bus trips for an estimated 5.7 million passengers in 2009; these figures do not include charter, tour, school, and non-South Station bus trips throughout the state
WATER-BORNE TRANSIT	2.7 million passengers and 590,000 vehicles per year on island ferries 1.22 million commuter ferry passengers per year 105 cruise ships from 15 cruise lines carry 300,000 passengers per year Port of Boston handles the majority of the state's bulk and containerized cargo; 11 ocean freight ports total
WALK/BIKE	12 percent Massachusetts residents and 24 percent Cambridge residents walk to work 48 percent of all downtown Boston trips are made by walking 13.3 percent walk and 1 percent bike to work in Boston (1st and 15th respectively of major US cities, and 1st in combined

Table 5: ***Massachusetts' Transportation Resources***

** References listed at the end of the chapter*

2. Expand the use of the statewide GIS-based system asset maps by combining them with updated floodplain mapping and revised peak flood flow calculations.
3. Formulate risk-based methods to evaluate service life of infrastructure assets against adverse climate change.
4. Update hydrologic and hydraulic analyses statewide, including engineering methods used in the calculation of peak flood flow rates, to reflect influence of climate change-induced events (e.g., the U.S. Geological Survey's Regionalized Peak Flow Equations for Massachusetts and the 50-year old National Weather Service's Precipitation Frequency Atlas, TP-40).
5. Research and Develop Engineering Solutions. The Massachusetts Department of Transportation and Massachusetts Port Authority should work with regional and municipal agencies to identify, develop and implement solutions—including reconstruction, removal, or relocation of vulnerable infrastructure—to protect existing assets from climate change impacts in the long- and short-term.
6. Protect Existing Infrastructure. Modifications include elevating, armoring, modifying, or relocating critical infrastructure. Airport, mass transit, port, and highway agencies should consider sizing stormwater management structures (e.g., pipes, culverts, outfalls) for future storm events and balancing upfront costs of incrementally larger structures today with the future costs of replacing an entire drainage system.

Short-Term Strategies

1. Public and private transportation entities should adjust standard maintenance and inspection procedures to take into account climate changes impacts, including increasing the frequency of routine inspections of coastal zone and inland bridges and drainage structures and initiating comprehensive regional asset damage inventories after major storm events.
2. Develop New Design Standards. Revise standards to be consistent with guidelines reflecting climate considerations issued by such entities as the American Association of State Highway and Transportation Officials, Federal Highway Administration, American Public Transit Association, Federal Transit Administration, U.S. Department of Transportation Maritime Administration, and the Federal Aviation Administration.

Long-Term Strategies

1. Encourage innovation across transportation sectors. Encourage use of new technologies at airports for navigation aids and airfield lighting systems that function better during storm events. New aircraft technologies could also improve landing and takeoff performance, potentially minimizing adverse impacts of more consistently high temperatures.
2. Enhance water-based transit options in affected coastal and riverine areas as a long-range transport alternative and as an interim back-up to damaged infrastructure.
3. Develop financing mechanisms. Evaluate and implement as necessary new ways to fund the anticipated expenses, including construction and long-term maintenance and operation costs, to address climate change impacts at the state and local levels.

Water Resources

Water-related infrastructure includes multi-component systems involved in procuring, treating, and distributing drinking water; collecting, treating, and discharging wastewater; managing stormwater; and using dams, levees, seawalls, and other structures to control surface hydrology. Most of the facilities that support these infrastructure resources are publicly owned by municipalities.

Existing Resources

Maintaining infrastructure associated with potable water is critical to the public health and safety of Massachusetts residents. Approximately 95 percent of the 6.5 million residents living in Massachusetts obtain their drinking water from one of the state's 531 community public water supply systems. The remaining 5 percent of Massachusetts residents obtain water from one of the estimated 550,000 private wells. Raw water from approximately 82 percent of the water sources is treated prior to being distributed for public consumption.

Approximately 79 percent of Massachusetts' 6.5 million residents discharge 785 million gallons of treated sewage into the state's waters each day through over 20,000 miles of pipe and 126 treatment facilities. According to the Massachusetts Water Resources Authority (MWRA), the Deer Island Sewage Treatment Plant alone treats an average of 350 million gallons of sewage per day from about 2.1 million people in 43 metro Boston communities (MWRA, 2010). Another 21 percent of the homes, municipal buildings, and businesses (Massachusetts Infrastructure Investment Coalition, 2007) are not connected to a sanitary sewer system and discharge

sewage to an on-site subsurface sewage disposal or to an approved treatment facility with a state groundwater discharge permit. There are 280 municipal and private facilities that discharge wastewater to groundwater (Felix, 2009).

Stormwater infrastructure is comprised of municipal separate storm sewer systems and combined wastewater and stormwater systems. Historically, stormwater management systems consisted of pipes, culverts, dams, detention basins, and storage reservoirs and were designed to convey stormwater, control peak flows, and prevent flooding. More recently, stormwater control measures have been designed to treat and infiltrate stormwater.

There are hundreds of dams and levees controlling water flow in rivers and streams throughout the state. Many of these are large structures that hold back significant volumes of water. Seawalls, groins, and other coastal flood control structures are common along the 1,500 miles of Massachusetts coastline.

Impacts and Vulnerabilities

Sea level rise could potentially inundate numerous municipal collection systems and some wastewater treatment plants along the Massachusetts coast and inland to a point where it could make economical sense to abandon them after their current useful lives. At other locations, it may make sense to use larger regional facilities (or expand existing upland facilities) for the treatment of wastewater and then use decentralized systems to discharge the treated water back in its original watershed. In general, to preserve water management operations (such as wastewater treatment, stormwater systems), it is important to take measures to reduce stress on river and coastal infrastructure such as dams, levees, and seawalls.

Another challenge is that existing Massachusetts Stormwater Management Standards apply only to sites undergoing development or redevelopment which are subject to review under the Wetlands Protection Act, Rivers Protection Act, or the Water Quality Certification Program, and do not apply to other upland areas that generate stormwater.

Potential Strategies

No Regrets Strategies

1. Continue to Facilitate Enhancement of Natural Systems. Redirect inflow from traditional stormwater collection systems into systems using low-impact design technology and restored natural hydrology to keep stormwater on site and increase available capacity and groundwater recharge. Increased use of groundwater recharge would also assist in reducing polluted runoff to surface waters, decrease flooding, and enable existing dams, levees, and other flood control structures to operate during more extreme storm events.
2. Continue to Promote and Expand Conservation and Reuse Efforts. Enhance ongoing efforts to conserve potable drinking water, reduce wastewater discharge, and decrease stormwater runoff. Implement the Massachusetts Water Conservation Standards and advance the use of treated wastewater, especially in commercial and industrial settings.
3. Coordinate Information Gathering. Coordinate efforts of land use planners, facility designers, and regulators in the collection and analysis of basic geographical, geologic, and engineering information needed to characterize vulnerabilities of water-related infrastructure systems.

Short-Term Strategies

1. Offset Impacts to Water Supplies. Consider revising the Massachusetts State Plumbing Code

Mother's Day Storm—Infrastructure Overwhelmed!

The 2006 Mother's Day storm began Friday, May 12 and, for the next 100 hours, dumped up to 15 inches of rain on many North Shore communities in Massachusetts. A U. S. Geological Survey flood gauge at Lowell showed that the flood level in the Merrimack River reached 59 feet, making it a 40-year occurrence event. On May 13, two days before flood levels in the Merrimack River peaked, a force main to the Haverhill Wastewater Treatment Plant gave way, spilling 35 million gallons per day of untreated sewage into the Merrimack River. The break occurred when the rapidly moving river in a tributary washed out a culvert that ran beneath a section of a power easement roadway and the force main. As the storm continued, waters flowed over bridges and into the streets and basements throughout the region. It took almost a week to repair the break.

The Department of Environmental Protection estimates that, had the water level in the Merrimack risen another two to three feet, wastewater treatment plants in the Greater Lawrence Sewer District would have lost their pumping stations and power to their treatment plants, resulting in major additional discharge of untreated sewage to the Merrimack River. It is also likely the drinking water treatment facilities in Tewksbury, Lowell, and Lawrence would have also become incapacitated.

to encourage and (in some cases) require water conservation. Assess the potential to increase water supplies through the reuse of non-potable water and use of greywater technologies.

2. Make Near-Term Changes to Publicly Owned Treatment Works. Evaluate flood-proofing vulnerable drinking water and wastewater facilities by raising the elevation of structures above predicted flood stages, installing watertight doors and windows, replacing wet/dry well pumps with submersible pumps, increasing emergency back-up provisions to keep all key equipment operational, and relocating vulnerable equipment. Ensure emergency and contingency plans include the use of backups, such as emergency generators for power generation.
3. Address Stormwater Flows
   a. For new development and redevelopment projects in upland areas, DEP should investigate developing requirements similar to those currently contained in DEP's Wetlands/ Water Quality Certification Regulations, which promote stormwater infiltration into the ground (i.e., at its site of origin where feasible), rather than direct run-off toward central stormwater drainage systems that discharge to surface waters. This will help decrease flooding, improve aquatic baseflow, recharge aquifers, and improve the quality of surface waters;
   b. Expand implementation of low-impact development as a stormwater mitigation mechanism;
   c. Periodically evaluate the long-term control plans for Combined Sewer Overflows (CSO) developed by the 24 Massachusetts CSO communities to determine if additional efforts are needed to protect the environment and public health from more frequent CSO activations. Free-up wastewater treatment and conveyance capacity by continuing to identify and remove infiltration and inflow from wastewater collection systems; and
   d. Expand public outreach and education efforts concerning the negative impacts of stormwater on flooding, the quality of rivers and streams, and the quantity of water in aquifers.
4. Enhance the SRF Program. Review and potentially modify the State Revolving Fund (SRF) Program —which provides $100 million of low-interest loans for water and wastewater projects—to encourage communities to address climate change impacts and avoid investments in highly vulnerable areas.

Early Experiences in Climate Change Adaptation at MWRA

During the 1980's and 1990's, the Massachusetts Water Resources Authority (MWRA) designed and constructed the massive Deer Island Wastewater Treatment Plant to meet federal regulations and provide environmentally sound treatment of wastewater from two million people in the metropolitan Boston area. A key component of the facility was construction of a 9.5 mile long, 24-foot diameter outfall tunnel into Massachusetts Bay, bored in solid rock 100 feet under the bay. Anticipating that the outfall would be in service for 50 to 100 years, MWRA engineers accommodated for changes in sea level in its design. As the sea level rises, water leaving the tunnel will push against a higher head, reducing the capacity of the tunnel and the treatment plant. In 1989, the designers reviewed the most current projections in climate modeling and decided to raise the entire plant about 1.9 feet higher to accommodate potential sea level change for at least the first 50 or 60 years of the facility's service.

5. Compile critical information on water and wastewater treatment facilities, including elevation data, location of pump stations and other affiliated structures; identify the location and capacity of stormwater conveyance waterways and structures.
6. Analyze how current flooding conditions and U.S. Federal Emergency Management Agency (FEMA) flood maps will change under certain climate change scenarios.
7. If appropriate, revise the Wetlands Protection Act Regulations and other regulatory tools that cite FEMA maps (which are required to reflect current and not future conditions) to reflect forecasted flood boundary alterations that may be linked to climate change.
8. Implement a program to educate water resource utility owners and operators on the vulnerabilities of their assets to climate change impacts.

Long-Term Strategy

Use Adaptive Management Techniques to Develop Long-term Infrastructure Sustainability Plans. Develop long-term sustainable solutions that include a mix of both decentralized resources and regional approaches. Some solutions may involve centralized or decentralized physical assets.

Dam Safety and Flood Control

As the major flood control structures used in Massachusetts, dams have been constructed for agricultural, industrial, and energy generation purposes. Many hydropower dams were constructed in the 17th century. The Department of Conservation and Recreation (DCR) Office of Dam Safety is responsible for the oversight of dam safety. Under current laws, responsibility for periodic inspections, inspection report preparation, and mandated preparation of emergency action plans for "high hazard potential" structures falls to the dam's owner.

Among the predicted climate changes for the Northeast U.S., extreme storm events, sea level rise, and increased intensity of precipitation pose the greatest threats to flood control structures (for more on flood control structures along the coast, such as sea walls, see section on 'Coastal Engineering for Shoreline Stabilization and Flood Protection' in Chapter 8) in Massachusetts, which, for the most part, were originally designed to control floodwater volumes and velocities based on historic weather patterns.

Existing Resources

There are more than 2,800 known dams in the state, most privately owned and operated. Of the known dams, at least 1,349 are not subject to the state dam safety regulations, due to their size, design, and ownership status. Of those subject to regulation (1545 dams):

- 304 are classified by the DCR as having a "high hazard" potential (dams located where failure will likely cause loss of life and serious damage to key infrastructure and the built environment);
- 727 are classified as having a "significant hazard" potential (dams located where failure may cause loss of life and may damage key infrastructure and built environment or cause temporary loss of use of services and key facilities); and
- 514 are classified as having a "low hazard" potential (dams located where failure may cause minimal property damage, and no loss of life is expected).

Unlike the case in many western and mid-western states, dikes and levees are not common in Massachusetts and other eastern states. A few highly specialized flood control structures are located in the state, including a hurricane storm surge barrier in New Bedford, flood diversion canals in North Adams, and levees located along the Connecticut River in Springfield, Holyoke, and Chicopee.

Many dams no longer serve the original purpose of their designs. Additionally, many contribute to major water quality problems—they can create a reservoir of contaminated sediments and severely limit the ability of waterways to use natural systems to help maintain clean water.

Potential Strategies

No Regret Strategies

1. Update modeling protocols and precipitation data. Use the Northeast Regional Climate Center data from 1993 (or most recent) in future safety analyses and design work until more up-to-date climate change data becomes available.
2. Prepare or revisit emergency action plans. Use approaches and assumptions in the preparation of emergency action plans that consider the most updated estimates of likely levels of precipitation, flooding, and extreme storm events, particularly when preparing or revising emergency actions that address "high hazard" dams.
3. Encourage cooperative efforts with federal and regional agencies to improve dam safety. Cooperate closely with federal agencies, the Association of State Dam Safety Officials, and various state agencies as new analytical data are developed and made available to the planning, engineering, and regulatory communities, including DCR data on dam locations and risk status for the entire state.

Short-Term Strategies

1. Develop Dam Planning within State Agencies. State agencies, with the Massachusetts Emergency Management Agency (MEMA) taking a lead role, should coordinate risk assessment planning for high hazard potential dams, using the worst-case assumptions of climate change impacts.
2. Mandated Insurance Program. Evaluate the value of establishing insurance requirements for dam owners and insurance companies to acknowledge and financially cover liabilities, anticipate future threats, address potential vulnerabilities, and reduce the state's expense in emergency response and cleanup.

Long-Term Strategies

1. Continue support for the Division of Ecological Restoration's river restoration program. The program helps facilitate dam removal with the

goals of preserving river continuity, maintaining the natural cleansing capability of waterways, and preventing water quality degradation associated with contaminated sediments build-up behind a dam.

2. Creative financing via federal and state opportunities. Explore various state and federal funding opportunities and evaluate expanding their eligibility criteria to provide low-interest loans for beneficial dam removal projects.
3. Continue to encourage the establishment of public, non-profit, and private partnerships to enhance efforts to target the removal of dams that either are deemed high hazard under DCR's rankings or which cause water quality or habitat impairments.
4. Seek to remove potential institutional barriers and evaluate the benefits of a streamlined dam maintenance and removal review and approval processes.

Solid and Hazardous Waste

Solid and hazardous waste infrastructure comprise solid waste landfills, combustion facilities, transfer stations, and hazardous waste treatment, storage, and disposal facilities. Other entities that have the potential to generate hazardous waste in the event of a natural disaster include waste generators such as retailers with hazardous materials (e.g., pharmacies and chain retail stores), certain chemical handling businesses, fuel tank farms, waste transporters, and residences equipped with heating oil tanks and containing hazardous household products.

Existing Resources

Massachusetts hosts 25 active solid waste landfills, seven solid waste combustion facilities, 230 active handling facilities (e.g., transfer stations), several large recycling facilities (e.g., the Springfield Materials Recycling Facility), and over 700 inactive landfills, many of which are located near environmentally sensitive wetland areas.

Most of the 12 hazardous waste treatment, storage, and disposal facilities (TSDFs) are not located in floodplains or coastal areas. One exception is Clean Harbors Braintree, New England's largest hazardous waste TSDF, which is located on the Fore River in Weymouth. Most facilities store their hazardous waste in containers that can be moved easily. Tank areas are above-ground and are diked to protect them from heavy stormwater run-off. In an emergency, hazardous waste in drums and tanks can be removed and shipped to a less vulnerable facility quickly, provided that roadways are passable.

Industries with hazardous waste and hazardous materials, however, are concentrated in coastal cities. There are approximately 680 large quantity hazardous waste generators and several thousand very small quantity generators in Massachusetts. Smaller generators may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event.

Impacts and Vulnerabilities

Climate change impacts could cause flooding of low-lying solid waste landfills, generation of large volumes of solid waste following a major storm event, and release of large amounts of fuel and hazardous materials (such as paints, solvents, and pesticides) from flooding of private homes and businesses.

More rainstorms and associated runoff could cause structural damage, increased release of leachate, or even exposure of waste at landfills located in historic wetlands and other sensitive locations. Erosion could increase because culverts and detention basins associated with solid waste facilities may not be able to handle increased runoff. More leachate could lead to a need for larger storage tanks or could cause increased discharge of leachate into the sewer system. If flooding conditions persist, contaminants from within the landfill could be carried away by floodwaters. Waste management services could be disrupted if facilities are closed due to damage or if capacity is exceeded due to an unexpected surge in solid waste production.

Potential Strategies

No Regrets Strategies

1. Enhance Geographic Information Systems (GIS) data for solid and hazardous waste management facilities.
2. Ensure that contingency plans for hazardous waste treatment, storage, and disposal facilities and large quantity generators include a description of procedures, structures, or equipment used at the facilities to prevent flooding and run-off from hazardous waste handling areas.

Short-Term Strategies

1. Develop better mapping data to identify solid and hazardous waste facilities that would be vulnerable to rising sea level and new, more frequent, or more severe flooding.
2. Consider requiring all solid and hazardous waste facilities operating in areas prone to coastal or inland flooding to prepare adaptation plans. This could be addressed through the permit renewal process.

3. Encourage local government agencies that oversee the operation or building of industrial facilities with hazardous waste and hazardous materials in areas prone to flooding to develop outreach materials on flood adaptation measures.
4. New retail gasoline fueling stations should be sited and designed using most recently available FEMA flood study and map information, incorporate additional provisions to address sea level rise over design life when located in a coastal flood zone, and contain appropriate containment systems, while older and abandoned gas stations should be identified and evaluated for their vulnerability under various climate change scenarios.
5. Enhance state and local efforts to regularly collect household hazardous waste.
6. Solid and hazardous waste infrastructure and emergency planning efforts should contemplate the need for possible temporary, large-scale storage of hazardous waste and materials generated from flooded properties.
7. Implement the Massachusetts Disaster Debris Management Plan as approved by the Federal Emergency Management Agency (FEMA). Implementing the recommendations of this plan will significantly enhance the abilities of local and state governments to respond to the challenges of managing disaster debris.

Long-Term Strategies

1. Develop a regional contingency plan for household hazardous waste collection during flood events.
2. Develop a detailed inventory of existing and potential hazardous waste generators and calculate the total hazardous waste facility storage capacity for Massachusetts.
3. Evaluate modification of the siting and design requirements for new and expanded waste management facilities to account for predicted site-specific climate change impacts that could be expected during the life of the facility.

Built Infrastructure and Buildings

Existing Resources

The built infrastructure and buildings sector encompasses the design, building, and operation of publicly- and privately-owned buildings. Many of them are situated in areas along the coast or major waterways and floodplains that may be particularly vulnerable to climate change impacts like storms and flooding.

Impacts and Vulnerabilities

Building design standards are based on historic climatic patterns. As climate patterns are likely to be very different in the future, the existing built infrastructure in the state could be adversely affected. Thermal stresses on building materials will be greater, cooling demands will be higher, existing flood-proofing may be inadequate, floodplains may extend to areas with unprotected structures, heat island effects may increase, corrosion of building materials may accelerate due to salt water intrusion, and building-related illnesses, primarily caused by mold build-up, may increase.

Potential Strategies

Strategies designed to protect existing and future buildings from predicted climate change impacts should consider the location of the existing/proposed building, the timing of when a projected climate change impact is expected to occur, the life-span of the structure, historical significance of the existing structure, and the cost and engineering involved with moving, demolishing-recycling, or protecting the structure.

The Spaulding Rehabilitation Hospital and Projected Sea Level Rise

Emergency facilities must do more than respond to natural disasters, they must also be planned and developed with these potential threats in mind. When planning its new eight story, 132-bed facility in the Charlestown Navy Yard, the Spaulding Rehabilitation Network considered both the current FEMA floodplain maps and sea level rise projections of between 0.27 m & 1.4 m (0.9 & 4.6 ft) over the next 75 to 100 years.

Designers concluded that a rise in sea level of two feet over 75 years was a reasonable projection, resulting in a shifting of the 100-year floodline. Taking into account height restrictions and the relationship of the building to the surrounding topography, the finished floor of the building has been established at 0.41 m (1.35 ft) higher than the new 100-year flood elevation and 0.11 m (0.35 ft) higher than the new 500-year flood elevation (as projected for 2085). Additional precautions include mechanical and electrical installations located on the roof, no patient facilities located on the ground floor or below, patient rooms having key-operable windows for emergency ventilation, and basement parking protected by establishing the top of ramp elevations set at the same level as the ground floor.

No Regrets Strategies

1. Require analysis of new construction and major renovation projects to include provisions to address predicted climate change impacts.
2. Use permitting and environmental review processes to recommend that new construction and renovation projects consider the use and protection of basement and first-floor levels, the installation of enclosures for roof-top equipment to protect them from more severe weather exposure, use of green roofs to absorb additional precipitation and decrease cooling needs, enhancement of site work to include bio-swales, the use of permeable pavement, construction of wetlands to handle surface water run-off, and raising the height of damp-proofing of foundations to accommodate increased flooding.
3. Consider climate change impacts in developing universal (accessible) design guidelines for all future projects.

Short-Term Strategies

1. Consider allocation of additional space in new building design and existing building retrofits to house the necessary mechanical equipment to handle increased heating, ventilation, air conditioning, pumping, or generator capacity.
2. Consider purchasing appropriately-sized generators and pumps to handle increased flooding and properly-sizing building structural components to carry additional precipitation and wind loads, and improve drainage around buildings.
3. Assess when and where to fortify existing buildings and when to move, demolish-recycle, or abandon vulnerable structures.
4. Plant shade trees to decrease solar/thermal load on buildings.

Long-Term Strategies

1. Evaluate modification of review and approval processes and building codes to require consideration of climate change impacts and life-cycle costs in public and private developments and construction activities.
2. Take steps to ensure that the life span of a building is in line with anticipated climate changes (i.e., a 50-year building will not be located in an area where flooding is projected in 30 years' time).

Information and Communications Technology

Information and communication technology stability and security in the face of climate change should be considered a high priority because of the pervasive influence of and reliance on this sector in daily life.

Existing Resources

Telecommunication networks are classified as either fixed (e.g., telephone and cable services using copper wire, coaxial cable, or fiber optics) or mobile (e.g., cellular and satellite connections). Information and communication technology services can be broken down into telecommunication services (broadband, mobile voice and data, and fixed voice) and broadcast services (television and radio). In Massachusetts, there is one primary local exchange carrier (Verizon). There are ten cable TV providers serving over two million subscribers in 308 of the state's 351 cities and towns (MassDTC, 2009). Massachusetts also benefits from 35 licensed full- and low-power TV stations (FCC, 2011a), 120 community TV stations (MassHome, 2010); 272 Federal Communications Commission-licensed radio stations (FCC, 2011b), and 745 licensed telecommunications operators (Mass DTC, 2011).

Impacts and Vulnerabilities

Information and communications infrastructure that could be affected by climate change effects include mobile and fixed radio, TV and cellular towers, satellite dishes, central office facilities, switching and base stations and foundations, manholes, underground pits, and thousands of miles of surface and subsurface wires, cables, and conduits.

The primary climate change impacts on this infrastructure would be extreme weather events, including flooding, erosion, heavy rainfall, coastal storm surges, and hurricanes. Additionally, high wind, lightning, and ice storm events could damage or destroy utility lines, poles, and towers. Increased temperatures and solar radiation could lead to a greater demand on certain equipment for cooling capacity and more rapid deterioration of aerial transmission cables. Salt spray from coastal storms and saltwater intrusion may increase corrosion of telecommunication towers and other equipment in coastal areas. While New England is forecasted to have an overall increase in annual precipitation, the region also may experience more seasonal drought periods, which could lead to forest fires and resulting infrastructure damage.

These varied events could adversely affect public safety, emergency, and transportation-related communications, as well as personal and business activities. The implications of these effects include increased capital and operating expenditures to repair, replace, redesign, or relocate telecommunications infrastructure at a faster rate. Other implica-

tions include a need to increase customer rates to cover infrastructure damage or replacement costs, to offset decreased productivity and maintain overall economic activity when systems are disrupted, and to re-establish compromised public health, safety, and security operations.

Some elements of the information and communication technology infrastructure have relatively long life spans and long lead times for design, approvals, and construction. They also may require high capital costs to implement.

Early in 2009, Governor Deval Patrick initiated an IT Collaborative to "organize the voice of the Information Technology industry through the creation of a sustainable, cross-cluster dialogue of stakeholders in business, government, and academia". This approach should include an emphasis on adapting the industry quickly to predicted climate change effects, such as increasing use of wireless technologies, achieving higher resilience standards (e.g., in mobile and fixed communication towers and transmission equipment), and reducing vulnerability and remediation costs.

The trend toward more wireless technology and the continued rapid evolution of information and communication technology should help the industry, as well as other impacted sectors dependent on this technology to adapt more successfully to extreme weather events and other predicted climate changes.

Potential Strategies

No Regrets Strategies

1. Inventory facilities, including transmission lines, towers, and satellite dishes; underground and underwater structures; computer terminals and peripheral equipment; broadcasting stations; and emergency communication systems for vulnerability to coastal and inland elements of climate change.
2. Support rapid updating of topographic and floodplain mapping.
3. Continue regular maintenance of existing infrastructure. Undertake a regional and national analysis of information and communication technology adaptation in the face of climate change, taking into account the lifecycle costs of these systems.

Short-Term Strategies

1. Identify lead times for climate change impacts and for redesigning, revamping, repairing, replacing, or relocating infrastructure elements. Adaptive planning should help accelerate the overall planning process, realizing that the technology itself is undergoing rapid change.
2. Incorporate climate change concerns into design standards and site selection while accelerating new sustainable technologies.

Long-Term Strategy

Assess the vulnerabilities of competing technologies to climate change risks, and ensure decision-makers involved in network upgrades or realignments are properly informed by this information. (Maunsell, 2008)

Commonalities Among Sectors and Strategies

Although the chapters in this report are organized into specific sectors, there are several interconnections among and within them. This section attempts to address those overlaps and interconnections between the Key Infrastructure sectors and the other chapters, and between the state's climate change mitigation efforts.

Key Infrastructure Interconnections

1. Energy and Transportation Sectors: Impacts to the energy and transportation sectors will influence the state's ability to adapt to climate change impacts affecting other forms of infrastructure, as well as in other sectors such as public health and economy, and will influence the state's ability to mitigate climate change. Losses of energy production and distribution and access to modes of transportation are identified as major climate change vulnerabilities in all sections of this report. Without a resilient and reliable source of energy and effective means of transporting people, goods, and services, it will be difficult for Massachusetts to adapt to climate change, prepare for or recover from emergency situations, and maintain state and national security objectives. As such, those strategies identified in the energy and transportation sectors should be considered not only as ways of protecting those individual sectors, but also as ways of protecting the other sectors throughout the state and region from the effects of climate change.
2. Water Resource Sectors: Many adaptation strategies identified to address potential climate change impacts are very similar among the three major water-based infrastructure resources: water supply, wastewater, and stormwater management. Examples from two broad categories, "design and operational features" and

"enhanced natural hydrology," demonstrate the interconnectivity of some key strategies among the water-based infrastructure sub-sectors.

a. Design and operational features: Strategies involving water conservation measures are common to both water supply and wastewater management. Reduced demand for water through measures such as water conservation, grey water reuse, and reduction in unaccounted-for water losses (e.g., leaking pipes), not only reduce the demand on public water supplies, but also reduce the amount of wastewater that needs to be managed. Reduced water use can protect against concerns about insufficient water supplies, especially during predicted periods of extended summer drought. Wastewater should be considered a commodity having considerable value in reuse, rather than just a waste flow that has no value. Additionally, less stress on these infrastructure systems generally results in greater resiliency to handle emergencies that may be caused and/or aggravated by climate change impacts. This will also result in reduced operational, management, and replacement costs. Low-impact design strategies also provide synergy of benefits to multiple water resource sectors.

b. Enhanced natural hydrology: Nature is effective in providing clean drinking water and managing wastewater and stormwater. Water resource managers are more often adopting watershed-based strategies that take a holistic view of water resource issues in a manner that considers the natural hydrology of a geographic area. Future decisions on water supply, wastewater, and stormwater management that mimic and reinforce the natural hydrology of a geographic area (e.g., a watershed) will enable natural systems to help manage future climate change impacts.

Lessons from the Dutch—Use of Natural Systems

The Dutch are well-known for their prowess in engineering structures designed to keep floodwaters out. In a country where about half the population lives below sea level, over 10,000 miles of flood defense contributes to the $2.5 trillion worth of existing infrastructure upon which the Dutch are highly dependent. In recent years, the Dutch have increasingly supported the use of natural barriers, such as sand dunes and marshes, to ease the force of storms and retain floodwaters and now ban drainage of existing marshes in further support of natural ecosystems over artificial systems.

Furthermore, the Dutch are adopting approaches aimed at carefully accommodating, rather than resisting, flood waters where possible. The essence of this principle (of integrated coastal policy) is: flexible integration of land in sea and of water in land, making use of materials and forces present in nature. The Dutch plan to return 222,000 acres of land to floodplain buffers for use as marshland or natural forest land. They have placed a moratorium on new flood-prevention infrastructure in some towns and are lowering, repositioning, or removing some dikes. This marks a significant change in the way they think of water by embracing land uses or construction types that tolerate soggy conditions.

Natural hydrologic systems have evolved to be flexible and adaptable to the extremes of weather phenomena, so strategies that reinforce and use natural systems can be very successful and cost-effective. These watershed -based approaches could be integrated more fully in the development of MassDEP's Comprehensive Water Resources Management Plans, which are required for certain water resources permitting and considered in funding assistance decisions.

3. Increased Conservation Measures and "Green" Designs

The State's vulnerabilities to climate change may be reduced if it decreases its reliance on and use of certain services. Additionally, natural ecosystems provide a number of services which support built infrastructure resources. By diminishing or eliminating non-climate stressors to infrastructure, that infrastructure may have more capacity to be resilient to climate changes. Here are a few examples to help illustrate this benefit:

a. Energy—Energy efficiency improvements and lowered demand will reduce loads on stressed electrical infrastructure while mitigating climate change through a reduction in greenhouse gas emissions.

b. Transportation—Reducing vehicle miles traveled reduces physical and capacity stresses on roads, bridges, and tunnels, increasing their resiliency to climate and weather-related impacts. When the population diversifies its travel patterns, individuals have greater flexibility in their transportation options. Reducing vehicle miles travelled also has implications for lower greenhouse gas emissions, providing climate change mitigation and reducing the need for adaptation.

c. Urban forests—Urban forests can perform a variety of vital infrastructure services. Trees are very effective in filtering pollutants from the air, as well as reducing volumes and pollutant loads from stormwater runoff. Increased urban vegetation and tree canopy, as well as innovative strategies such as green roofs, are also very effective in reducing the heat island effect in urban areas, which can reduce the demand and stress on energy infrastructure.

Charles River Natural Valley Storage Project

In 1910, the Charles River was dammed, creating the "Charles River Basin." In subsequent years, however, residents feared that the dam would significantly increase flooding during major storms. Brought in to study the precipitation data, the US Army Corps of Engineers noted a surprising lack of flooding in the towns north of Newton. It attributed this to a series of isolated wetlands that naturally store and gradually release water to the Charles River, buffering the effects of particularly rainy seasons on the river's water levels. In light of this information, Congress authorized the purchase of 17 wetlands (8103 acres) for $8.3 million, creating the "Charles River Natural Valley Storage Area." At the time, the Army Corps of Engineers was also considering a $100 million dam construction project to serve the same purpose, but decided in favor of the wetland solution.

Since 1974, when the purchase was authorized, the decision is believed to have created benefits of over $7.5 million to the local economy and has prevented flood damage estimated at $3.2 million. Additionally, property values bordering these wetlands sell at a 1.5 percent premium. Use of this natural solution over a significantly more expensive engineered solution has already paid for itself in a way the second dam never could. The Charles River Natural Storage Area is a living example of an economical, environmentally conscious solution.

 The symbol signifies adaptation strategies that are also climate change mitigation actions.

REFERENCES

Amato, A., M. O. Ruth, P. Kirshen, and J. Horwitz, 2005. Regional Energy Demand Responses to Climate Change: Methodology and Application to the Commonwealth of Massachusetts. Climatic Change, Vol. 71, #1, pp.175-201.

Brekke, L. D., J. E. Kiang, J. R. Olsen, R. S. Pulwarty, D. A. Raff, D. P. Turnipseed, R. S. Webb, and K. D. White, 2009. Climate change and water resources management—A federal perspective: U.S. Geological Survey Circular 1331, 65 p. (Also available online at http://pubs.usgs.gov/circ/1331/.)

Federal Communications Commission, 2011a. TV Query of Video Division Database of the Media Bureau. http://www.fcc.gov.

Federal Communications Commission, 2011b. FM Query and AM Query of Audio Division database of the Media Bureau. http://www.fcc.gov.

Felix, J., September 2009. Department of Environmental Protection. Personal communication.

Felix, J., December 2009. Department of Environmental Protection. Personal Communication.

Ferris, D., September 2009. Department of Environmental Protection. Personal communication.

Massachusetts Department of Telecommunications and Cable, 2009. Annual Report, pp. 2 and 4. Online at: http://www.mass.gov/dtc.

Massachusetts Department of Telecommunications and Cable, 2011. Mass. Licensed Telecomm. Operators.

Massachusetts Infrastructure Investment Coalition, 2007. Infrastructure Status Report: Massachusetts Wastewater Facilities. http://www.engineers.org/tec/file/Infrastructure%20Status%20Report%20on%20Waste%20Water.pdf.

MWRA (Massachusetts Water Resources Authority), April 20, 2010. Personal communication from Kristin MacDougall, Office of Public Affairs.

Maunsell Australia Pty Ltd, May 2008. Impact of Climate Change on Australia's Telecommunications Infrastructure. Garnaut Climate Change Review.

Misslin, M., September 2009. Department of Conservation and Recreation. Personal communication.

Morris, M., September 2009. Department of Environmental Protection. Personal communication.

Paterson, J., September 2009. Department of Environmental Protection. Personal communication.

Terry, D., September 2009. Department of Environmental Protection. Personal communication.

United States Department of Energy, 2008. Retail Sales Information for Massachusetts, Energy Information Administration.

Worrall, E., September 2009. Department of Environmental Protection. Personal communication.

MassHome, 2010. 120 community TV stations, as of April 9, 2010: http://www.masshome.com/tv.html.

Other Useful References

Metcalf & Eddy, Inc. for Massachusetts Water Resources Authority, 1989. Conceptual Design, Design Package 6, Effluent Outfall Tunnel and Diffusers, Final Design Report, May 31, 1989 p 6-1 to 6-5.

Nickerson, C., December 5, 2005. Holland Goes Beyond Holding Back the Tide. The Boston Globe.

Waterman, R. E., 1991. Integrated Coastal Policy Via Building with Nature. Impact of Sea Level Rise on Cities and Regions. Proceedings of the First International Meeting. Ed. Roberto Frassetto. Venice, Italy: Centro internazionale Citta d'Acqua, pp 60-63.

Table 5 References

ROADS

Lane Miles: 2009 Massachusetts Road Inventory Year-End Report.

Bridges: MassDOT Bridge Condition Report April 1, 2010.

Freight by Truck: Communication from Paul Nelson, EOTC Office of Transportation, September 23, 2009.

RAIL

MBTA passengers: MBTA Draft Capital Investment Program FY11-FY15 Report, p. 8.
MBTA Service Area: "About the MBTA" section on "The New MBTA" at www.MBTA.com.
MBTA capital assets: MBTA Draft Capital Investment Program FY11-FY15 Report, p. 9.
Amtrak Information: AMTRAK Fact Sheet, FY2009, State of Massachusetts at www.AMTRAK.com.
Commercial Rail: Communication from Paul Nelson, EOTC Office of Transportation, September 23, 2009.

AIR

Logan Airport information: Communication from Stewart Dalzell, Massport, May 3010.
All other information: Communication from Katie Servis, MassDOT Aeronautics Division, May 2010.

BUS

RTA passengers: SFY 2008 RTA Performance Report, MassDOT Office of Transportation Planning, Transit Planning Unit, December 2009.
MBTA buses and THE RIDE: MBTA Draft Capital Investment Program FY11-FY15 Report, p. 8-9.
South Station bus traffic: Communication from Stephen Squibb, South Station General Manager, April 20, 2010.

WATER-BORNE TRANSIT

Island ferries: Communication from Robert Davis, treasurer/comptroller, Wood's Hole, Martha's Vineyard and Nantucket Steamship Authority, April 12, 2010.
Commuter ferries: Communication from Lauren Coughlin, Manager of Private Carrier Services, MBTA, August 26-27, 2009.
Cruise ships: Massport, 2009 Port of Boston data, provided by Massport April 2010.
Ocean freight terminals: Communication from Paul Nelson, EOTC Office of Transportation, September 23, 2009.

WALK/BIKE

MA and Cambridge statistics: walkBoston website at www.walkboston.org.
Boston downtown statistics: walkBoston website at www.walkboston.org.
Boston walk/bike statistics: Bicycling and Walking in the United States 2010 Benchmarking Report, Alliance for Biking & Walking, 2010; Major US City Post-Oil Preparedness Ranking, Comment Current, November 10, 2008; US Census press release June 13, 2007; US Census 2005 American Community Survey, released Oct. 27, 2009.

Case Studies

Impacts of the Ice Storm of December 2008:

http://www.boston.com/news/local/massachusetts/articles/2008/12/13/ice_storm_paralyzes_parts_of_new_england/
http://weather.about.com/b/2009/03/15/fema-funding-update-for-the-december-2008-ice-storm.htm
http://www.fema.gov/news/newsrelease.fema?id=48250
http://www.mass.gov/?pageID=eoeeapressrelease&L=1&L0=Home&sid=Eoeea&b=pressrelease&f=110209_pr_unitil_orders&csid=Eoeea

Mother's Day Storm—Infrastructure overwhelmed!: Massachusetts Department of Environmental Protection.

The Spaulding Rehabilitation Hospital and Projected Sea Level Rise: Hubert Murray FAIA, RIBA, Partners Health Care, April 2010.

Early Experiences in Climate Change Adaptation at MWRA: Metcalf & Eddy, Inc. for Massachusetts Water Resources Authority, Conceptual Design, Design Package 6, Effluent Outfall Tunnel and Diffusers, Final Design Report, May 31, 1989, p 6-1 to 6-5.

Lessons from the Dutch— Use of Soft Approaches:

Waterman, R. E., 1991. Integrated Coastal Policy Via Building with Nature. Impact of Sea Level Rise on Cities and Regions: Proceedings of the First International Meeting. Ed. Roberto Frassetto. Venice, Italy: Centro Internazionale Citta d'Acqua, 60-63.Nickerson, C., December 2005. "Holland Goes Beyond Holding Back the Tide." The Boston Globe.

Charles River Natural Valley Storage Project: Army Corps of Engineers, 2006. Charles River Natural Valley Storage Project, Value to the Nation, http://www.nae.usace.army.mil/recreati/crn/crnhome.htm.

6 — Human Health and Welfare

SUBCOMMITTEE CHAIRS:	Ann Lowery	Department of Environmental Protection
	Michael Celona	Department of Public Health

ADVISORY COMMITTEE PARTICIPANTS:

Eugene Benson	Alternatives for Community and Environment
Roseann Bongiovanni	Chelsea Greenspace and Recreation Committee
Andrew Cavanaugh	University of Massachusetts–Amherst
Paul Epstein	School of Medicine, Harvard University
Timothy Griffin	Tufts University
Arthur Marin	Northeast States for Coordinated Air Use Management

OTHER CONTRIBUTORS:

Ruth Alfasso	Department of Public Health
Kathleen Baskin	Executive Office of Energy and Environmental Affairs
Leon Bethune	Boston Public Health Commission
Sean Bowen	Department of Agricultural Resources
Brian Brodeur	Department of Environmental Protection
Catherine Brown	Department of Public Health
Suzanne Condon	Department of Public Health
Janet Curtis	Department of Energy Resources
Yvette DePeiza	Department of Environmental Protection
Neenah Estrella-Luna	Suffolk University
Yana Garcia	Alternatives for Community and Environment
Russell Gaulin	Department of Environmental Protection
John Graham	Northeast States for Coordinated Air Use Management
John Grieb	Department of Public Health
Michael Hutcheson	Department of Environmental Protection
Christian Jacqz	MassGIS
Peter Judge	Massachusetts Emergency Management Agency
Gerard Kennedy	Department of Agricultural Resources
Sharon Lee	Department of Public Health
Richard Lerner	Department of Public Health
Jennifer Mieth	Department of Fire Services
Madelyn Morris	Department of Environmental Protection
Joe Pelczarski	Office of Coastal Zone Management
Vandana Rao	Executive Office of Energy and Environmental Affairs
Timothee Rodrique	Department of Fire Services
Margaret Round	Department of Public Health
Paul Schumacker	Boston Public Health Commission
Marina Spitkovskaya	Alternatives for Community and Environment
Jeffrey Trask	Massachusetts Emergency Management Agency
Gregor Trinkaus-Randall	Board of Library Commissioners
Elizabeth Wade	Board of Library Commissioners
Carol Rowan West	Department of Environmental Protection
Hotze Wijnja	Department of Agricultural Resources

INTERNS: Craig Altemose, Celine Clabaut, Cassandra Snow, Kira Sargent

6 Human Health and Welfare

Introduction

Changes in climate will undoubtedly affect human health and welfare in Massachusetts—both directly via extreme heat events and indirectly through increases in vector-borne diseases. Climate change will affect the quality of the air we breathe, the shelter we rely on, the quality and quantity of the water we consume, the food we grow and transport, and the nature and level of demands for health care services.

Some residents will be more susceptible to the effects of climate change, and adaptive change will be more difficult for them. Whether by virtue of economic status, social capacity and resources, health, age, or geography, adaptation efforts should include planning to meet the unique needs and conditions of the state's most vulnerable populations—including those with limited resources to take protective and adaptive measures and to recover after losses, and those coping with existing chronic illnesses that could be aggravated by the expected climatic changes. Children, the elderly, the disabled, and low-income groups, in particular, should be considered in any adaptive plan. A focus on vulnerable populations requires an understanding of community or population characteristics, conditions that could contribute to a disproportionate risk, and obstacles to resiliency. (Note that in this chapter, strategies that are especially applicable to vulnerable populations are denoted by "VP".)

The maintenance, support, and improvement of existing public health and health care infrastructure are critical to the overall preparedness for the effects of climate change. To support and promote a strong, healthy, and resilient population, and responsive local health systems, adaptation efforts for human health should build on conventional and existing medical and public health standards, using a variety of approaches. These approaches may include using health surveillance systems to track disease occurrence and identifying locations and population groups at greatest risk for specific health threats. These efforts may also include assessing infrastructure capacity and emergency response preparedness, developing preparedness and response plans, and creating treatment plans to reduce health risks. Effective adaptation and mitigation strategies should seek to reduce exposure and increase resilience. These efforts can be executed at scales ranging from large-scale regional initiatives to delivery of personalized health services. This chapter examines topics within the following categories outlined in Table 6.

General Overview of Vulnerabilities

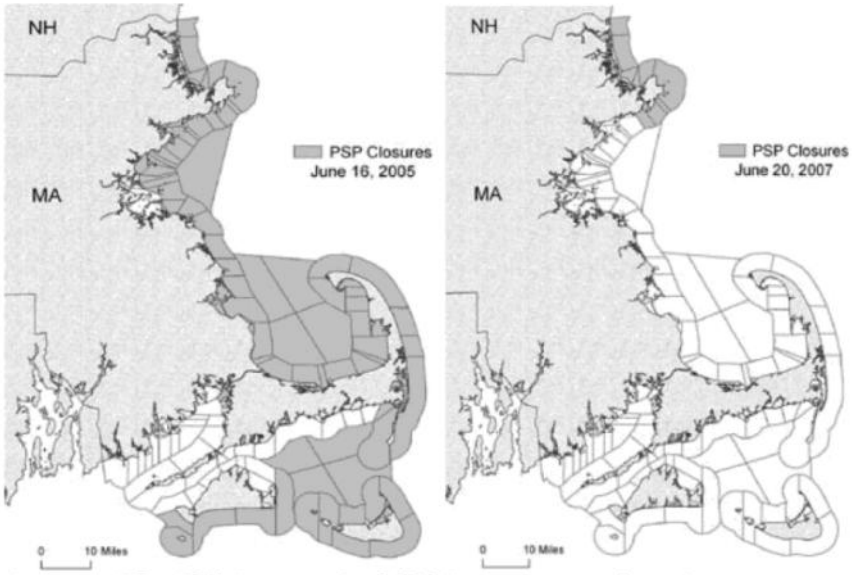
Vulnerabilities of each of the above categories are closely interconnected. As an example, an increase in precipitation will lead to increased runoff of nutrients and chemicals into water bodies, potentially compromising surface water quality and possibly affecting drinking water quality. Water laden with nutrients promotes the emergence of algal blooms, which release into the air and water toxins harmful to humans and animals, and which can contaminate shellfish stocks.

In general, climate change impacts on human health may include:

- higher temperatures contributing to complications or exacerbation of conditions

CATEGORY	TOPICS
Public Health	Public health infrastructure, vector-borne diseases, heat stress, allergens, respiratory and cardiovascular diseases, extreme and anomalous weather events
Air Quality	Ambient and indoor air quality
Water Quality/Sanitation	Drinking water, algae blooms, wastewater, water-borne diseases
Agriculture and Food Systems	Crops and livestock, water demand, pesticide use, new or invasive pests, food transmitted illnesses, security and safety
Vulnerable Populations	Food security, pesticides, allergens, air and water quality, vector-borne diseases, recovering from extreme weather events

Table 6. ***Public Health topics examined in this chapter***



A record Red Tide event in 2005 led to extensive closures throughout state waters (left) while 2007 saw shorter closures confined mainly to the North Shore (right).

among those with respiratory illnesses and cardiovascular disease;

- increased ozone and particulate matter production, coupled with higher temperatures, which result in poor air quality, and increased risk to those with existing respiratory diseases;
- increased plant pollen production and more allergenic pollen content, which may aggravate and exacerbate allergies, asthma and other respiratory illnesses;
- changes in disease patterns and a possible increase of vector-borne diseases (including Lyme disease, Eastern Equine Encephalitis and West Nile virus) as ticks and mosquitoes adapt to changing conditions;
- increased potential for water-borne disease outbreaks during and after flooding events;
- degraded surface water quality from sediments, pathogens, nutrients, and pesticides in stormwater and agricultural runoff;
- shifts in shellfish pathogens, with possible increasing contamination and closed shellfish beds;
- extreme weather events such as ice storms, heat waves, and more powerful storms that disrupt power and sanitary services, health care services, and access to safe and nutritious food, and which cause damage to homes and property; and
- increased mental and physical health burdens from the need to cope with more extreme weather, disaster response, and uncertainty.

Advancing Adaptation and Mitigation from a Public Health Perspective

While some greenhouse gas reduction (climate mitigation) measures will improve public health and welfare (such as reducing carbon emissions from cars), others may have significant adverse health and environmental consequences (such as potential increased national reliance on nuclear power without nuclear waste management improvements or proper consideration of potentially harmful public health consequences resulting from climate change impacts to nuclear reactors, particularly those sited along the coast). Likewise, adaptation strategies, such as increased use of air conditioning, may contribute to further climate change. A life cycle analysis that examines the health, environmental, and economic costs of proposed technologies and practices is a useful method for projecting potential co-benefits and potential costs of implementing them (Epstein et al., 2008).

The following are complementary mitigation and adaptation strategies that have multiple public health and environmental benefits.

- A Healthy Cities Initiative: Promote green buildings, rooftop gardens, walking paths, biking lanes, tree-lined streets, open space, access to locally grown healthy food, flood control systems that mimic natural processes, low impact development techniques, motor vehicle transit / congestion control, smart growth, and improved clean public transport. These strategies will reduce the heat island effect, decrease vehicular miles traveled, promote exercise, save money, support local agriculture and healthy nutritious diets, create jobs, and advance climate-stabilizing technologies. The State's June 2009 landmark transportation reform legislation created "The Healthy Transportation Compact" which supports this strategy. The compact involves the transportation, public health, and environmental agencies "work[ing] cooperatively to adopt best practices to increase efficiency to achieve positive health outcomes through the coordination of land use, transportation and public health policy" (www.massdot.state.ma.us, click on Healthy Transportation Compact link).
- Alternative fuel vehicles: Hybrid and electric vehicles can minimize fossil fuel combustion, reduce emissions of particulates (such as black carbon), ozone precursors, and CO_2, which will

The Chicago Heat Waves of 1995 and 1999

Heat waves are responsible for approximately ten times as many fatalities per year as hurricanes, rainstorms, lightning, floods, and tornadoes combined. Lessons learned in other parts of the country can help guide Massachusetts' response to heat waves.

In the summer of 1995, the city of Chicago experienced a heat wave that killed 739 residents. The temperatures reached a peak of 106°F (41°C) during the day, while night time lows were still in the high 70s and low 80s. Temperatures stayed in the 90s and 100s for over a week. As air-conditioner usage soared, area utilities could not cope with the record-breaking energy demand and 49,000 households lost electricity—leaving them even more vulnerable to the overbearing heat. Fatalities were highest among those who lived alone, had little access to transportation, did not leave the house on a daily basis, and lacked an air conditioner.

In 1999, when Chicago was hit by another heat wave, it was better prepared with a more responsive municipal effort. Chicago officials responded faster to the weather, alerting the press and the public, providing free transportation to rapidly opened cooling centers around the city, and checking in on elderly people through phones and in-person visits by police officers. Fatalities attributed to the heat wave numbered 110 that year.

Today the city is taking additional steps to prepare it for a warmer summer—water and heat trapping alleyways are being replaced by permeable materials, heat hot-spots are being targeted for pavement removal, plants are being added to roofs, and trees that are more resistant to higher temperatures are being planted citywide.

ultimately decrease unhealthy emissions, and benefit urban areas in particular.

- Improving the electricity grid infrastructure: A more efficient distribution grid can reduce air emissions from existing power plants, which in turn can mitigate expected increases in ground level ozone and particulate matter that result from higher ambient air temperatures.

The rest of this chapter covers key aspects of public health and offers no regret, short-term, and long-term adaptation strategies for each sub-category in response to potential climate change impacts. The following narrative outlines strategies that will continue to be reviewed and considered for implementation.

Public Health Infrastructure

Massachusetts has a comprehensive and sophisticated public health infrastructure with a variety of resources—material and human, local and statewide, governmental and private—that support disease prevention, surveillance, and management.

At the municipal level, boards of health are responsible for public health issues and enforcing public health regulations. Local and state public health officials share enforcement responsibility for state sanitary and housing codes. In addition, several regional boards or health department associations (e.g., Franklin Regional Council of Government, Nashoba Valley Association of Boards of Health) exist to provide additional services to member communities. There are 15 regional health coalitions in place to strengthen public health preparedness and capacity.

At the state level, the Massachusetts Department of Public Health (DPH) provides services to residents, enforces regulations, and operates several hospitals and a state public health laboratory. DPH provides technical assistance to local boards of health, and manages a range of programs focused on disease surveillance, communicable disease control, and environmental health.

The public and private health care system provides acute and chronic care to residents through hospitals, community health centers, nursing homes, and private practice offices. These entities are the primary sources of data for disease tracking and surveillance. The public and private health care system employs over 100,000 professionals at more than 125 hospitals and rehabilitation facilities, 600 clinics and community health centers, 500 nursing homes and hospices, 65 psychiatric and mental health facilities, 300 Emergency Medical Services units, 35 Medical Reserve Corps, and 5 Veterans Affairs Hospitals. A large number of medical care facilities are located near the coastline around the Greater Boston area where the population concentration is highest.

Vulnerabilities

The effects of climate change will potentially stress each component of the public health infrastructure. Public and private health care systems will need to respond to increased occurrences and demand for

treatment of acute and chronic diseases and ailments such as heat stress, exacerbation of pre-existing asthma, new diseases, mental health effects such as anxiety resulting from displacement under emergency circumstances, and physical trauma from flooding.

DPH Assists Communities Understand and Plan for Climate Change

The Massachusetts Department of Public Health (DPH) is one of five entities (four states and one city) to be awarded a $345,000 three-year cooperative agreement under the Centers for Disease Control and Prevention (CDC) Climate Change Ready States and Cities Initiative to conduct needs and capacity assessments and to help create plans for cities and towns to address the human health consequences of climate change. Under this program, DPH will work primarily with Massachusetts local health officials, but will also coordinate such efforts with the Massachusetts Climate Change Adaptation Advisory Committee. The project proposal uses information developed in this chapter and references many of the goals and strategies presented in this chapter. This important award will allow the DPH to assist Massachusetts communities with understanding and planning for the potential health effects associated with climate change.

Boards of health will need to respond to increasing burdens in the areas of housing, sanitation, disease, and other public health issues arising from sea level rise, higher summer temperatures, and extreme weather events. Other impacts will result from the potential interruption of transportation and energy generation and transmission critical to providing health care, and interruption of services at hospitals and health care centers.

The greatest vulnerability to the local health infrastructure is likely to be the lack of resources. Boards of health have broad responsibilities and face difficulties in enforcing a wide variety of existing public health regulations and responding to local, small-scale emergencies. Public health goals, and the extent to which they are met by boards of health, vary greatly depending on staff resources and experience, access to testing and tools, and the community's overall capacity for emergency response. In the event of an increased number of emergencies, state or regional boards and other entities may need to divert resources—sometimes all available resources—to the emergencies at the expense of executing core public health programs.

Vulnerabilities in the private health care system include ongoing challenges in the capacity to handle an increasing number of patients with chronic illnesses, such as asthma, and surges of patients after climatic events. The possibility of migration into Massachusetts from other states and countries, so called "climate refugees," could add to the demand for emergency response and public health services.

Facilities and supporting infrastructure near the coastline and in floodplains are particularly vulnerable to rising sea level and increased flooding. Hospitals are an energy-intensive commercial sector, and are consequently vulnerable to power disruptions from weather events, as well as to increasingly higher energy costs.

Potential Strategies

Existing public health infrastructure may be able to meet the challenges expected from climatic changes. Still, planning at all levels of health infrastructure could begin to evaluate and identify climate-related vulnerabilities in order to adjust priorities and plan for improving our response capabilities.

The current public health infrastructure could undergo a system-wide climate change needs assessment. Planning documents already contain much of the information needed for such an assessment, although they do not organize the information to assist adaptation planning. Changes in the current local public health program model, such as enhancing regionalization efforts to address non-emergency situations, can allow for more efficient mutual aid and increased coverage across the state. The need for enhanced capacity in core public health activities could be met by a regional system that supports the critical skills necessary to prevent disease and injury in communities.

The public and private healthcare system may need to plan for physically modifying or relocating vulnerable health care facilities located along the coastline or in floodplains. In addition, a more detailed evaluation of current provider capacity to meet the needs of more patients suffering from climate change-related ailments is needed.

Short-Term Strategies

1. State, regional, and local public health officials may begin to incorporate climate vulnerabilities into existing plans.
2. State, regional, and local public health officials could begin to conduct public health climate change planning to identify the most vulnerable facilities and response capacity from the state to the facility level.
3. Consider promoting an education campaign targeted to vulnerable populations, which could include support for a network of notification procedures for vulnerable communities, cooling

Operation Helping Hands

"Operation Helping Hands," the Massachusetts response to assisting evacuees from Hurricane Katrina, was a broad and comprehensive program to coordinate the efforts of federal, state and non-profit organizations to assist approximately 250 Katrina area evacuees who were transported to Massachusetts within a few days of the event.

The Massachusetts Department of Public Health (DPH) is the primary support agency responsible for coordination of "state public health, mental health, medical, and health care resources during activation of the State Emergency Operations Center". The response included:

- administration and management tasks, such as making sure evacuees had identification;
- medical assistance, including acute care, management of prescription medications, and assistance in obtaining replacement eyewear;
- mental health evaluation and care for both existing chronic illness and post-traumatic stress;
- public health measures such as assuring access to applicable vaccinations and the collection and sharing of standardized information with other responding states; and
- social support, such as assisting with food, clothing and housing; assistance regarding pets; school registration, and assistance with finding other family members and developing plans for the future.

Approximately 60 staff and volunteers were coordinated as a part of this effort, along with about 100 National Guardsmen. Additional efforts were required to assure that volunteers had proper credentials.

Many lessons were learned from this experience in Massachusetts, including the need for immediate structured, yet flexible, responses to emergencies, and the usefulness of the Massachusetts Medical Society, the regional Center for Public Health Preparedness and the Medical Reserve Corps. Having access to a fallow military base for immediate housing and other

centers (gathering places for people to get relief during heat waves), and "check on your neighbor" programs (VP).

4. Consider assessing the capacity of providers to address anticipated increased patient volumes and changing health demands, including capacity to address heat waves and anomalous winter weather events.
5. Seek to implement the DPH asthma action plan to improve the ability to adequately treat chronic asthma with effective care plans.
6. Promote participation in energy efficiency programs for the health care sector such as the U. S. Department of Energy's Hospital Energy Alliance and Energy Smart Hospitals and the U. S. Environmental Protection Agency's Energy Star for Healthcare.

Long-Term Strategies

1. Facilitate and enhance regionalization efforts among local boards of health.
2. Encourage distributed sources of energy generation (such as community-scale solar and wind power) to increase preparedness and resiliency of the network of health care providers, and to decrease emissions.
3. Promote workforce development to train public health staff to respond to climate change-related health threats.
4. Identify facilities and strategize how to modify or relocate vulnerable health care facilities away from the coastline, improve flood control protection, or stabilize facilities in flood prone areas.
5. Support efforts to reduce greenhouse gas emissions, which in turn, would reduce long-term health effects of climate change.

Vector-Borne Diseases

Vector-borne diseases are transmitted by carriers such as insects and arthropods. In Massachusetts, Lyme disease, babesiosis, human granulocytic anaplasmosis, tularemia, and Rocky Mountain spotted fever are spread by ticks. West Nile virus and Eastern Equine Encephalitis virus are spread by mosquitoes. Several of these diseases can cause serious illness or even death. Others could become established in Massachusetts as a result of changing climatic patterns.

Warming Temperature and Vector-Borne Diseases

Eastern equine encephalitis is Massachusetts' most severe vector-borne disease. With the general trend of warmer temperatures leading to higher mosquito numbers and greater activity, the possibility of more human disease will apply to all mosquito-borne diseases, including West Nile virus and St. Louis encephalitis virus. A similar trend is probable with tick-borne diseases as well, resulting in the prospect of more human cases of Lyme disease, babesiosis (a malaria-like parasitic disease), and anaplasmosis (a bacteria which infects white blood cells).

Vector life cycles, particularly of the mosquito, are dependent on temperature and moisture, making impacts from climate change likely. Populations particularly vulnerable to vector-borne diseases include people who are elderly, very young, un- or under-insured, outdoor laborers (i.e., farm and construction workers), those geographically isolated from health care services, and those with low levels of education, low-income, or compromised immune systems.

Existing Resources

Health care providers and veterinarians are required to report the occurrence of certain vector-borne diseases (e.g., West Nile virus, Eastern Equine Encephalitis, and Lyme disease) to the appropriate state agencies. Mosquito control districts assist with mosquito surveillance and control, while DPH conducts mosquito surveillance and virus testing on mosquito, animal, and human samples. DPH also routinely tests samples to detect the emergence of new mosquito-borne diseases. Limited tick and tick-borne pathogen surveillance occurs through academic institutions and cooperative extensions. The environmental control of ticks occurs mainly through individual use of fee-for-service pesticide application companies. DPH records and analyzes data collected on human cases of some vector-borne diseases. In addition, DPH creates educational materials for the public to encourage personal prevention practices, and for health care providers to promote prompt recognition of certain vector-borne diseases and appropriate treatment.

Vulnerabilities

With climate change, the general public will likely be subject to greater exposure to disease vectors and related pesticide application. The likely effects of predicted climate change are prolonged transmission seasons for all vector-borne diseases, extending the risk of transmission outside of the traditional late spring through early fall timeframe. In addition, mosquito populations are likely to increase as rising temperatures shorten reproductive cycles and result in more generations per season. There will be a greater demand for monitoring, treatment, and health services. Increased suspected human cases may tax laboratory resources and potentially limit their capacities to perform other work needed to detect the emergence of new pathogens.

Although warming temperatures will not increase the speed at which tick vectors reproduce, warmer winters may decrease tick mortality and would likely support an abundant tick population. Unless populations of preferred tick host species such as white-tail deer and small rodents diminish, an increased risk of transmission to humans can be expected. Substantial increases in the number of the more serious tick-borne diseases, such as human granulocytic anaplasmosis, babesiosis, and Rocky Mountain spotted fever, could result in rising use of medical resources. In addition, babesiosis could pose a threat to blood supply since many carriers who could be potential blood donors are asymptomatic, and most blood recipients are immuno-suppressed and more vulnerable to developing severe diseases. Because surveillance of tick populations and pathogens is not as systematic or centralized as surveillance of mosquitoes, detection of new tick species and/or identification of emerging pathogens spread by ticks could be delayed.

Potential Strategies

Short-Term Strategies

1. Continue requiring reporting of human cases and positive laboratory results of vector-borne diseases including diseases that are not currently endemic to Massachusetts.
2. Work to improve capacity to respond to vector-borne diseases, streamline and automate reporting mechanisms, and stockpile supplies for prevention (e.g., insect repellent, repellent impregnated work clothing).
3. Continue to develop and enhance electronic reporting procedures for laboratories.
4. Maintain mosquito surveillance at multiple sites throughout Massachusetts.
5. Continue testing to identify other, currently non-endemic, viral agents.
6. Educate the public, particularly high-risk groups, about personal prevention practices, and encourage their adoption.
7. Educate the public about mosquito breeding habitats and opportunities to eliminate them (such as reducing areas of standing water).

Long-Term Strategies

1. Consider developing a systematic tick surveillance program statewide to monitor vector densities and infection rates.
2. Evaluate the benefits of implementing a web-based disease reporting procedure for health care providers.
3. Evaluate and support service providers in expanding institutional capacity to meet the needs associated with climate change induced increases in vector-borne diseases.
4. Consider using community-based groups and trade organizations to do outreach and education about risks and prevention, and to connect individuals and families to appropriate services (VP).

5. Examine developing occupational health and safety regulations to protect outdoor workers (VP).
6. Facilitate monitoring of current non-endemic diseases for trends (VP).
7. Develop strategies for large-scale use of integrated pest management control to reduce pesticide use (VP).
8. Improve capacities to conduct vector and human surveillance in order to identify high-risk groups and places to better target outreach, education, and prevention efforts (VP).

Ambient Air Quality

Climate change alters local weather patterns, such as temperature and wind speed, which, in turn, affect the distribution of air pollution. Anthropogenic sources of air pollution promote climate change through the emission of CO_2, volatile organic compounds and oxides of nitrogen. Volatile organic compounds, oxides of nitrogen and sunlight combine to form ozone and smog, which are harmful to public health, ecology, and public welfare. Byproducts of combustion, such as, ozone and fine particulate matter, contribute to air pollution and associated respiratory and cardiovascular disease.

Massachusetts Environmental Public Health Tracking Network

The Massachusetts Department of Public Health (DPH) recently launched a web-based Massachusetts Environmental Public Health Tracking network, which contains data on ambient air quality, hospitalizations due to asthma and myocardial infarction, and pediatric asthma for all Massachusetts communities. Using information from this tracking network, federal, state, and local public health agencies, the medical community and advocacy groups will be better prepared to develop and evaluate effective public health actions to prevent or control these diseases.

Principal public health concerns are allergy symptoms related to increased allergen production, and increased respiratory and cardiovascular disease related to worsening air pollution and higher temperatures. Particularly vulnerable populations include the elderly; the very young; low-income groups; immigrants; the homeless; un- or underinsured people; residents with increased exposure to ambient asthmagens; residents of older or substandard housing; people who are geographically isolated from health care services; people with certain pre-existing conditions, especially asthma or lung dysfunction or compromised immune systems; and outdoor laborers such as farm and construction workers.

Existing Resources

The Massachusetts Department of Environmental Protection (DEP) is responsible for monitoring outdoor air quality and developing regulatory programs to reduce emissions of pollutants that adversely affect public health, welfare, and the environment. DEP provides data on criteria pollutants (sulfur dioxide, ozone, carbon monoxide, nitrogen dioxide, lead, particulate matter ≤10 microns and ≤ 2.5 microns), controls many other pollutants emitted from facilities (e.g., power plants, incinerators, vehicles), and administers the Massachusetts regulatory portion of the Regional Greenhouse Gas Initiative. The DPH Bureau of Environmental Health evaluates environmental and health data to determine the likelihood of health effects associated with environmental factors.

Vulnerabilities

Warming conditions may increase ground-level ozone and particulate matter levels, allergens, and extreme heat events which, in turn, can exacerbate existing cardiovascular and respiratory conditions and other health effects. Meteorological changes can impact local and regional pollution distribution, with a number of modeling studies (Tagaris et al., 2007; Murazaki and Hess, 2006) predicting accumulation and concentration of pollutants (e.g., ozone) in the Northeast. An increase in ambient temperature is likely to stimulate earlier flowering, increased growth and prolonged pollen production in plants, which can increase and prolong asthma and allergy incidents. Also, the potency/strength of pollen can increase as a result of higher temperatures and carbon dioxide levels. The increases in allergenicity of plant materials can lead to more severe respiratory responses. In addition, synergistic effects can be expected from entrainment of respirable-sized particles that attach to pollen are delivered deep into the lungs and contribute to, or worsen lung dysfunction. Increased plant growth correlates to increases in decomposition—suggesting heightened fungal abundance. Such increases may result in greater amounts of airborne spores which are linked with exacerbation of asthma.

Individuals with pre-existing respiratory and cardiovascular conditions will be the most susceptible to decreased air quality, especially those who do not have access to quality health care. People who work outdoors most of the day will be disproportionately impacted. The heat island effect in urban areas will exacerbate air quality deterioration and disproportionately impact lower-income individuals who do not have ready access to air

conditioning or health care, as well as people who work outside in urban environments. An increase in pollen production and its allergenicity will impact individuals statewide. The increasing need for health care will likely stress the existing health care and public health infrastructure if certain adaptation strategies are not implemented.

Potential Strategies

Training of and coordination between physicians, other health practitioners, local health officials, and other components of the health care industry will help mitigate health impacts resulting from decreased air quality through improved primary health care for affected populations. Determining how each health and environmental agency manages adaptation and data tracking as a whole will assist in coordinating care. Some of this work may be integrated into existing programs or centralized through agency coordination. In order to understand local impacts of climate change risks, it is important to identify sensitive populations, develop targeted preparedness and response plans, and develop the capability to conduct health impact assessments that evaluate health outcome data and relevant air quality indicators associated with climate change.

To minimize future air quality impacts, more aggressive emissions controls (both in the U.S. and elsewhere) will be needed to make progress toward reducing emissions of particulates and key ozone precursors (especially NO_x so that ozone concentrations are below health-based standards). The primary strategy for responding to health impacts from climate change is preventing the occurrence of illness and injury by reducing risk factors, early detection and treatment of disease, and effective preparedness and emergency response plans. To accomplish the goal of preventing illness and injury due to climate change, more specific efforts could include:

Short-Term Strategies

1. Achieve and maintain air quality standards. Attain air quality standards for ozone; continue to attain current federal particulate matter standards. Continue to control direct particulate emissions and precursors of particulates such as sulfur and oxides of nitrogen and other asthmagens.
2. Enhance clean energy generation programs. Control emissions from sources such as industrial and wood burning facilities and diesel engines.
3. Build on the existing public health practice of surveillance and health outcome tracking in order to identify and monitor health impacts related to climate change.
4. Promote telecommuting to avoid exposure during air quality alerts.
5. Promote heat island effect reduction strategies: cool roofs, green roofs, green spaces, and designs that minimize heat magnification.
6. Encourage opportunities for public transit use, walking, and bicycling, and evaluate expanding facilities that promote these transportation options.
7. Seek to increase use and installation of green infrastructure such as trees and other vegetative cover, with preference for hypoallergenic species.
8. Create mechanisms to provide technical advice and communicate the health-related aspects of climate change, including risks and risk reduction. Disseminate air quality ratings to the public, decision makers, local health departments, and healthcare providers, and ensure that the information is accessible to all residents (i.e., translated from English to relevant native languages and distributed broadly in affected communities).
9. Enhance scientific understanding of the relationship between climate change, air quality, and health outcomes by conducting health impact assessments at the state and local levels.
10. Use existing DPH and census data to identify and physically locate vulnerable populations (VP).
11. Expand capacity for modeling and forecasting health effects using standardized health impact assessment methods to incorporate climate change.

Long-Term Strategies

1. Explore and develop multi-pollutant strategies to reduce greenhouse gas emissions, criteria air pollutant emissions, and air toxics emissions.
2. Continue monitoring and meeting regional haze requirements by decreasing haze-forming pollutant emissions, with a goal of restoring natural visibility conditions in our state and national parks and wilderness areas.
3. Encourage and invest in expansion of scientific and technological research to identify novel means to reduce air pollution.
4. Facilitate improved access to health insurance and medical care, medical support equipment and medications (VP).
5. Support expansion of strategic planning efforts to assist both health-related service providers and health care recipients in meeting anticipated needs associated with climate change impacts.
6. Prioritize planting of hypoallergenic trees in communities with high rates of asthma and lung dysfunction (VP).

7. Consider providing technical and financial support to companies to reduce their ambient air emissions (specifically ozone precursors and particulate matter) (VP).
8. Examine the feasibility of reducing or removing subsidies for activities and projects that result in reduced ambient air quality (VP).

Indoor Air Quality

Climate change impacts on both outdoor air quality and the built environment have the potential to negatively impact indoor air quality. If there are increasing numbers of "bad air days" due to poor outdoor air quality, people may spend more time indoors. Buildings as shelter are the first line of defense against a sub-optimal outdoor environment, but they can also be severely impacted by the effects of climate change. Increased temperature and precipitation, as well as extreme weather events, can degrade the building envelope, allowing moisture and pest penetration, mold growth, and off-gassing from building materials in the indoor environment. The natural solution is dilution with outdoor air. However, when ambient air quality is poor, using it to dilute indoor pollutants may not be recommended. Strategies are needed to decrease exposure to indoor air pollutants, particularly during poor air quality days.

Existing Resources

To understand the effects of climate change on indoor air quality, a number of indicator data can be used, including environmental data sets, building history, weather/meteorology, and floodplain forecasts. As discussed in the previous section, DEP is responsible for monitoring outdoor air quality and developing regulatory programs to reduce the emission of pollutants that impact human and environmental health and welfare. The Massachusetts School Building Authority and the Division of Capital Asset Management are beginning to examine the age and needs of existing government-owned buildings, so that the highest priority risks and building needs of the most vulnerable properties can be identified and addressed. Further, the DPH Indoor Air Quality program has conducted assessments of hundreds of schools and other public buildings in Massachusetts, generating data to further identify vulnerable areas. There is a need for similar examination by private property owners. Where flood damage may be severe, building modification or even relocation may need to be considered. Both forecasting and floodplain information are important for identifying geographic risks related to climate change, pinpointing buildings most at risk, and predicting the extent of damage that may occur.

Vulnerabilities

Flooding can have severe impacts on buildings, properties and their occupants. When water penetrates a structure, it can compromise its integrity, promote mold growth, and cause aggravated health responses in compromised populations (asthmatics and those with pre-existing respiratory conditions). Mold can induce irritant symptoms, particularly among those with pre-existing respiratory conditions who may experience more aggravated effects (i.e. asthma attacks). Responding to water damage issues can be very costly and especially burdensome for those without health or homeowners insurance, and financial considerations add to the stress or trauma of adequately responding.

Saturated soils can cause damage to building structures (i.e., cracking, collapse) and buried components can provide further points for moisture penetration. If water-damaged porous materials such as gypsum wallboard are not dried within 24 to 48 hours, the damaged materials should be removed and replaced. Appropriate containment practices should be used during remediation to prevent exposure. Those with pre-existing conditions, such as asthma, or who are immuno-compromised may be displaced during the remediation process. This displacement can cause short- and medium-term stress and trauma.

Conversely, prolonged periods of water shortage (i.e., droughts) can cause soils to dry out and settle. This can damage building foundations and create pathways for later moisture penetration. Droughts are associated with increases in airborne particulates, particularly if there are wildfires. Increased dust loads can cause irritant symptoms, and exacerbate conditions of those with pre-existing respiratory conditions.

Increased temperature (with high humidity levels) can directly degrade building components, promoting indoor condensation and mold growth (cracks in roofs allow more water entry, for example). Increases in temperature/UV index can also result in off-gassing from building materials. Overall increases in temperature can magnify the effects of the urban heat island effect and accelerate building deterioration.

There may not be enough cooling center capacity to manage the expected increases in heat stress and illness, particularly in urban areas. Heat stress can be a trigger for respiratory, cardiovascular, and cerebrovascular episodes, such as heart attacks and strokes. An increase in temperature is often coupled with an increase in ambient ozone levels, which is a respiratory irritant. This can also cause increased indoor ozone levels (from penetration through open windows or increased ventilation rates) which can result in the production of more toxic compounds as ozone interacts with household products.

An extended growing season could result in increased numbers of pests including flies, mosquitoes, and cockroaches. Window screens are required by the state sanitary code to be used in homes to prevent pest intrusion through open windows. With increased degradation rates in homes, breaches in the building envelope can also allow pests to enter. In turn, this may result in increased exposure to toxic compounds as a result of increased use of pesticides.

Potential Strategies

Strategies for emissions reductions are particularly important in this area. Improvements in building materials can help prevent off-gassing, improve energy efficiency and recovery, improve air filtration, and make buildings mold resistant. Buildings are also high energy users, with energy expended in producing building components, building construction, and operating costs. Reducing the embedded energy and operational costs related to buildings can reduce adverse impacts and air pollution from energy generation.

Information such as building surveys and histories can help building owners anticipate water damage, and meteorological data and associated indexes can help building owners anticipate and prepare for heat-related incidents. Building renovations, efficiency improvements to buildings, and the energy supply network provide an opportunity to improve capacity to manage extreme heat events.

Short-Term Strategies

1. Educate property owners about existing and future floodplains to encourage implementation of methods to reduce damage.
2. Seek to increase cooling center capacity, particularly in urban areas.
3. Encourage or mandate use of reflective paints and materials, and white roofs to decrease heat stress on buildings.
4. Consider targeted surveying of buildings (residential, commercial and public) to identify structural needs and vulnerabilities.
5. Promote installation of drainage improvements, insulation, and vapor barriers or retarders, and provide instruction on appropriate drying and salvage efforts.
6. Compile a database of areas expected to experience localized street flooding throughout the state and share this information with interested parties.
7. Consider enhancing construction standards for buildings to be resilient to climatic impacts, including flood, and hurricane resistance.
8. Improve overall drainage around buildings and on thruways. Consider installing building drainage that infiltrates stormwater into the ground or storage for use during droughts.
9. Promote the increased use and installation of natural systems for control of stormwater and flooding.
10. Expand use of porous pavement to improve drainage on roadways and prevent run-off into buildings or into ground surrounding buildings with basements or crawlspaces.

Long-Term Strategies

1. Continue to support research and development in heating, ventilation, and air-conditioning and the clean energy fields to ensure that reduced energy consumption and improved indoor air quality are achieved.
2. Continue to support research and development of building components that resist microbial growth, reduce emissions of volatile organic compounds, and have low environmental impact.
3. Encourage the planting of shade trees, use reflective, light colored paints and use alternate cooling practices (i.e. more ceiling fans, green roofs, and urban open space and garden areas) to reduce the impacts of heat stress on buildings and the general population.
4. Seek to implement the Governor's Zero Net Energy Buildings Task Force recommendations.
5. Continue using the State Sanitary Code (105 CMR 410.000: Minimum Standards of Fitness for Human Habitation, State Sanitary Code, Chapter II) to protect tenants, and require property owners take action to remediate water-damaged building materials, including mold contaminated materials. Resources to assist the DPH and local boards of health to enhance this activity should be considered (VP).
6. Continue to have the DPH Indoor Air Quality Program provide technical service to building/ home owners and local boards of health concerning remediation of water damage in

buildings.

7. Initiate and implement efforts to educate health care providers regarding health risks related to mold exposure and encourage health care providers to contact appropriate persons (e.g., local or state health department) to investigate potential exposures (VP).
8. Evaluate opportunities to provide technical and financial support to property owners to remediate mold (VP).

Water Quality

Different patterns of precipitation, drought, flooding, and extreme events will all have an impact on the quality of water and its use for drinking, food processing, recreation, commercial and industrial production, and energy generation.

Vulnerabilities

Sea level rise, higher storm surges, and more extreme precipitation patterns can affect the quality and quantity of water supplies. Saltwater intrusion in coastal water supplies could affect drinking water quality and lead to increased corrosion of pipes and related infrastructure. Extreme precipitation patterns may also result in higher and faster streamflows which, in turn, can lead to over-bank flooding, stream channel erosion and sedimentation, and impacts to surface water bodies (see Chapter 5 on impacts to infrastructure, and Chapter 4 on impacts to natural resources). Surface and groundwater may become contaminated as extreme precipitation and floods release toxic material, nutrients, and pathogenic microorganisms and parasites from land surfaces. Flooding can cause sewage systems to fail and overflow, increasing hazards from sewage-related pathogens and toxic materials. High turbidity levels in ground or surface waters contribute to an increase in disinfection by-products with a greater potential for bacterial regrowth within drinking water distribution systems. Increased precipitation and water levels may provide breeding grounds and harborage for pests, resulting in an increased potential for water-borne diseases.

Increased nutrient enrichment of salt and freshwater systems from increased runoff can lead to an increase in algae blooms and shellfish pathogens. These issues carry high societal costs, which potentially include the loss of drinking water supplies; increased water treatment costs; increased frequency of water-borne disease incidents, food recalls, and shellfish bed closings; and decreases in trade, tourism, and allied industries.

Finally, periods of reduced rainfall resulting in drought could reduce stream flows, snow pack, aquifer recharge, contaminant dilution, and dissolved oxygen. Intense droughts may also put more pressure on local water supplies and agricultural irrigation needs. Populations vulnerable to the effects of drought include people with heightened sensitivity to water quality (the elderly, some low-income groups with higher exposure to poor water quality, and people with compromised immune systems), households dependent on private wells, and individuals and families lacking access to clean water recreational resources. Large and small businesses that rely on large amounts of water (such as power plants, manufacturing facilities, laundries and farms) are also particularly vulnerable.

Potential Strategies

Short-Term Strategies

1. Continue to monitor water quality reports, toxicology reports, epidemiologic reports, and the impacts of storms and hurricanes on water-borne diseases.
2. Create a forum for gathering information on exposures and diseases related to extreme weather events and flooding, and the potential impact of climate change on morbidity and mortality.
3. Educate the public about ecologically-sound landscaping practices, which reduce reliance on chemical fertilizers that can enrich freshwater systems with ecosystem-disrupting nutrients.
4. Work with communities and provide local authorities with information about the impacts of weather on water supply and increased inland and coastal flooding.
5. Seek to redirect and reduce flooding through improved stormwater management techniques including reducing impervious surfaces and using best management practices, and potentially relocating problematic pollutant sources from flood plains.
6. Identify water and sewer facilities susceptible to saltwater intrusion and coastal inundation.
7. Evaluate and prioritize implementation of improved controls of agricultural, urban, and stormwater runoff to prevent ocean and freshwater contamination, as well as enrichment of nutrients in aquatic areas that offer ideal growth medium for harmful algal blooms.
8. Assess and plan for impacts on regulatory and incident response resources. This will require an expansion of the emergency response workforce at all levels to enforce regulations, address water shortages, provide pest control measures, and respond to disease outbreaks.

9. Support local mutual aid collaboration to develop contingency plans to respond to water supplies impacted by climate change.

Long-Term Strategies

1. Consider re-evaluating standards for the design and maintenance of septic systems and implement changes as necessary to offset climate change related impacts.
2. Conduct outreach and education on water conservation practices, and reducing the use of pesticides and fertilizers.
3. Identify means to improve and implement water management, including improving and enforcing water quality protections.
4. Seek to implement and enforce legal and design standards to reduce agricultural, urban, and stormwater runoff.

Agriculture and Food Systems

The primary impacts of climate change, including increased air temperature, more frequent and severe drought, and more high-intensity precipitation events, could directly influence the productivity and resilience of agricultural systems in Massachusetts. Plant and animal species used in agriculture respond to these factors individually and interactively; plants respond directly to the principal cause of climate change i.e., increased atmospheric CO_2 concentration. There are a number of secondary impacts as well such as changes in crop species (including opportunities for new crops or varieties and loss of existing crops); increasing pressure from existing plant and animal pests that respond to temperature; and emergence of new or invasive pests as warmer climate ranges shift northward. There are additional impacts on agriculture and the food system that will be realized principally as public health and welfare effects, rather than direct agricultural effects.

Vulnerabilities

While there is some potential for benefit to certain crops (mostly cool-season crops) from the direct effects of increased carbon dioxide (CO_2 fertilization) and from a longer growing season, the negative impacts of higher temperatures and more erratic and severe weather far outweigh any benefits. The ability to produce food is susceptible to increased pest pressure from insects, diseases, and weeds that is likely to result from higher annual temperatures. New and organic farmers, who may be less experienced, have fewer options in terms of agricultural chemicals, have potentially less access to capital for infrastructure improvements, and are vulnerable to increased pest and disease pressure.

Many farms, particularly those with less access to working capital for infrastructure improvements, are vulnerable to erosion from an increase in heavy rains, and to crop loss from longer and more frequent droughts. An increase in heat stress days (maximum temperature of more than 90°F) will have a strong negative impact on farming and livestock, especially milk production in dairy cows. Increased use of pesticides against increased plant pests and diseases will potentially create risks to pesticide applicators, farm workers, the public, the environment, immigrants, low-income residents, pregnant women, young children, and those who rely on subsistence fishing. Warming trends have been linked to increases in marine and freshwater algal blooms, as well as seafood-borne toxins. Uncooked seafood, particularly shellfish, may pose new health threats through increases in infectious or toxic organisms.

Also, extreme weather events may contribute to movement of toxins into different environments from run-off, which may then affect food supply. Ocean acidification through CO_2 settling may impact seafood supplies with adverse effects on organisms' abilities to form shells, and could result in ecosystem ripple effects. With respect to outdoor recreational activities provided by agriculture, impacts on crops such as apples, berries, and maple syrup may reduce the opportunities for certain popular and emblematic New England outdoor activities such as apple and berry picking and maple sugaring.

Populations vulnerable to climate change impacts on food systems include the elderly, low-income communities, immigrants, people who rely on subsistence fishing, those living in areas with limited or no access to affordable nutritious food ("food deserts"), and people with low health status, particularly those with illnesses most severely impacted by diet (i.e., diabetes, heart disease, and cerebrovascular disease).

Potential Strategies

Local agriculture has been expanding in Massachusetts for the last few years, keeping pace with a growing awareness of the benefits and importance of locally grown food. Beyond the issues of food quality and a desire to preserve the infrastructure necessary to ensure food security, agriculture plays a role in the state's cultural heritage and helps to preserve dwindling open spaces. Farmers face enormous challenges in adapting to the changes that are likely to result from climate change. Resources that could mitigate these

challenges include ongoing programs to monitor food supply and pest/disease outbreaks, an existing inventory of land suitable for agricultural use, public communication on food safety and food security issues, and a regulatory system for registration and use of pesticides.

Short-Term Strategies

1. Continue to monitor food supplies for potential disease outbreaks.
2. Consider providing funding and personnel to monitor for new insects, weeds, and pathogens that are likely to expand their ranges into Massachusetts.
3. Revisit integrated pest management thresholds and strategies in light of changing pest population dynamics.
4. Encourage adoption of best practices to control runoff of pesticides, nutrients, or fertilizers, and soil, which contribute to poor water quality.
5. Consider providing low- or no-cost loans for infrastructure adaptations such as irrigation, drainage, and livestock facilities.
6. Expand educational efforts for pesticide risk management, crop adaptation and management, and conservation practices.
7. Increase efforts to monitor the use and occurrence of pesticides in the environment.
8. Continue to track food-borne illnesses to determine if new patterns or agents are emerging.
9. Provide technical assistance and outreach in partnership with existing federal programs (such as U.S. Department of Agriculture's Natural Resources Conservation Service) that deliver programs at the state or county level.

Long-Term Strategies

1. Facilitate research on crop adaptation and diversity.
2. Seek to identify and understand specific impacts of climate change on food supplies, food quality, and disease transmission to develop appropriate policies and regulations.
3. Consider increasing food subsidies for lower income residents, and modify eligibility requirements to ensure access to healthy food (VP).
4. Evaluate the benefits of modifying development/ zoning priorities to increase access to places to purchase fresh food (VP).
5. Investigate providing technical and financial support to assist small farms to bring produce to new markets, particularly in urban areas. This may include support for participation in community-supported agriculture by low-income families (VP).
6. Promote and provide/increase technical and financial support for small-scale farming (VP).
7. Evaluate the opportunity to provide disaster assistance or insurance for small farms for crop losses (VP).
8. Strive to improve and enforce water quality protections for water bodies that are used for subsistence fishing (VP).
9. Examine providing technical and financial support to farmers for transitioning to new crops and infrastructure (VP).
10. Increase and improve support for and enforcement of federal and state OSHA and workplace safety laws relating to pesticide/ herbicide exposure prevention (VP).
11. Conduct outreach and education targeting vulnerable population groups and their employers about health and safety precautions (VP).
12. Study potential improvements to state health and safety laws relating to pesticide/herbicide exposure prevention (VP).

 The symbol signifies adaptation strategies that are also climate change mitigation actions.

REFERENCES

Epstein, P. R., W. Moomaw, and C. Walker (eds.), July 2008. Healthy Solutions for the Low Carbon Economy: Guidelines for Investors, Insurers, and Policy Makers. http://chge.med.harvard.edu/programs/ccf/documents/healthy_solutions_report.pdf.

Hess, J. J., J. N. Malilay, A. J. Parkinson, 2008. Climate Change. The Importance of Place. Am J Prev Med, 35 (5):468–478. Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine.

Murazaki, K., and P. Hess, 2006. How does climate change contribute to surface ozone change over the United States? J, Geophys. Res., 111, D05301, doi:10.1029/2005JD005873.

Strategic Plan for Asthma in Massachusetts 2009–2014, Massachusetts Department of Public Health, May 2009. On line at: http://www.mass.gov/Eeohhs2/docs/dph/com_health/asthma/state_plan.pdf.

Tagaris, E., K. Manomaiphiboon, K. J. Liao, L. R. Leung, J. H. Woo, S. He, P. Amar, and A. G. Russell, 2007. Impacts of global climate change and emissions on regional ozone and fine particulate matter concentrations over the United States. J. Geophys. Res., 112, D14312, doi:10.1029/2006JD008262.

Other Useful References

Bell, M. L., R. Goldberg, C. Hogrefe, P. L. Kinney, K. Knowlton, B. Lynn, J. Rosenthal, C. Rosenzweig, and J. A. Patz, 2007. Climate change, ambient ozone, and health in 50 US cities. Climatic Change (2007) 82:61–76 DOI 10.1007/s10584-006-9166-7, Published online: 6 January 2007, # Springer Science + Business Media B.V. http://environment.yale.edu/uploads/publications/Bell_2007_Clim_Change.pdf.

Bloomberg, M. R., R. T. Aggarwala, 2008. Think Locally, Act Globally. How Curbing Global Warming Emissions Can Improve Local Public Health. Am J Prev Med, 35(5) 0749-3797/08/$–see front matter © 2008 Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine doi:10.1016/j.amepre.2008.08.029.

English, P. B., A. H. Sinclair, Z. Ross, H. Anderson, V. Boothe, C. Davis, K. Ebi, B. Kagey, K. Malecki, R. Shultz, and E. Simms, 2009. Environmental Health Indicators of Climate Change for the United States: Findings from the State Environmental Health Indicator Collaborative Environ Health Perspect: doi:10.1289/ehp.0900708.

Esterling, W. III, B. H. Hurd, J. B. Smith, June 2004. Coping with global climate change, The Role of Adaptation in the United States. Prepared for the Pew Center for Global Climate Change.

Gage, K. L., T. R. Burkot, R. J. Eisen, E. B. Hayes, 2008. Climate and Vector borne Diseases. Am J Prev Med, 35 (5):436–450, © 2008 Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine.

Gamble, J. L. (ed.), K. L. Ebi, F. G. Sussman, and T. J. Wilbanks, 2008. Analyses of the effects of global change on human health and welfare and human systems. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency, Washington, DC, USA.

Hayhoe, K., C. Wake, B. Anderson, X. Liang, E. Maurer, J. Zhu, J. Bradbury, A. DeGaetano, A. M. Stoner, and D. Wuebbles, 2008. Regional climate change projections for the Northeast USA. Mitigation and Adaptation Strategies for Global Change. Volume 13, Numbers 5-6, 425-436, DOI: 10.1007/s11027-007-9133-2.

Hayhoe, K., C. P. Wake, T. G. Huntington, L. Luo, M. D. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. Degaetano, T. J. Troy, and D. Wolfe, 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Climate Dynamics 28:381-407, DOI 10.1007. Online at: www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

Jacobson, M. Z., 2008. On the causal link between carbon dioxide and air pollution mortality. Geophys. Res. Lett., 35, L03809, doi:10.1029/2007GL031101.

Karl, T. R., J. M. Melillo, and T. C. Peterson, (ed.s), 2009. Global Climate Change Impacts in the United States. Cambridge University Press. Online at www.globalchange.gov/usimpacts.

Keim, M. E., 2008. Building Human Resilience: The Role of Public Health Preparedness and Response As an Adaptation to Climate Change. Am J Prev Med, 35(5):508–516. Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine.

Kinney, P. L., 2008. Climate Change, Air Quality, and Human Health. Am J Prev Med, 35(5):459–467, © 2008 American Journal of Preventive Medicine.

Lancet and University College London Institute for Global Health Commission, 2009. Managing the health effects of climate change. 373: 1693–733. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)60935-1/fulltext#article_upsell.

Maibach, E. W., C. Roser-Renouf, A. Leiserowitz, 2008. Communication and Marketing As Climate Change–Intervention Assets.—A Public Health Perspective. Am J Prev Med, 35(5):488–500, © 2008 American Journal of Preventive Medicine.

Mohan, J. E., L. H. Ziska, W. H. Schlesinger, R. B. Thomas, R. C. Sicher, K. George, and J. S. Clark, 2006. Biomass and toxicity responses of poison ivy (Toxicodendron radicans) to elevated atmospheric CO_2. PNAS 2006 103: 9086-9089.

Morello-Frosch, R., J. Sadd, and M. Pastor, May 2009. The Climate Gap: Inequalities in How Climate Change Hurts Americans & How to Close the Gap. http://college.usc.edu/geography/ESPE/perepub.html.

Patz J. A., S. J. Vavrus, C. K. Uejio, S. L. McLellan, 2008. Climate Change and Waterborne Disease Risk in the Great Lakes Region of the U.S. Am J Prev Med, 35(5) 0749-3797/08/$– © 2008 American Journal of Preventive Medicine. Published by Elsevier Inc. doi:10.1016/j.amepre.2008.08.026/.

Semenza, J. C., D. E. Hall, D. J. Wilson, B. D. Bontempo, D. J. Sailor, L. A. George, 2008. Public Perception of Climate Change Voluntary Mitigation and Barriers to Behavior Change. Am J Prev Med, 35(5):479–487) © 2008 American Journal of Preventive Medicine.

Union of Concerned Scientists, October, 2006. Climate Change in the Northeast. A Report of the Northeast Climate Impact Assessment. http://www.northeastclimateimpacts.org.

University of Maine Climate Change Institute, February 2009, Revised April 2009. Maine's Climate Future. http://climatechange.umaine.edu/.

Wise, M., K. Calvin, A. Thomson, L. Clarke, B. Bond-Lamberty, R. Sands, S. Smith, A. Janetos, and J. Edmonds, 2009. Implications of Limiting CO_2 Concentrations for Land Use and Energy. Science 324 (5931), 1183. [DOI: 10.1126/science.1168475].

Wolfe, D. W., Z. Lewis, C. Petzoldt, A. Seaman, L. Chase, and K. Hayhoe, 2007. Projected change in climate thresholds in the Northeastern U.S.: implications for crops, pests, livestock, and farmers. Received: 14 November 2006 / Accepted: 15 March 2007, # Springer Science + Business Media B.V. 2007 Mitig Adapt Strat Glob Change Volume 13, Numbers 5-6, 555-575, DOI: 10.1007/s11027-007-9125-2.

U.S. Environmental Protection Agency Energy Star for Health Care. http://www.energystar.gov/index.cfm?c=healthcare.bus_healthcare.

Younger, M., H. R. Morrow-Almeida, S. M. Vindigni, A. L. Dannenberg, 2008. The Built Environment, Climate Change, and Health Opportunities for Co-Benefits. Am J Prev Med, 35(5):517–526, published by Elsevier Inc. on behalf of American Journal of Preventive Medicine.

Case Studies

The Chicago Heat Waves of 1995 and 1999:

http://www.slate.com/id/2068612/

http://www.nytimes.com/2011/05/23/science/earth/23adaptation.html?_r=2&src=me&ref=science.

Operation Helping Hands: Condon S, E. Savoia, S. M. Orfaly Cadigan, M. Getchell, J. Burstein, B. Auberach, and H. Koh, 2010. Operation Helping Hands: Massachusetts' Health and Medical Response to Hurricane Katrina. Prehospital and Disaster Medicine. Volume 25, Issue 1, January/February.

Massachusetts Environmental Public Health Tracking Network: http://matracking.ehs.state.ma.us/

7 — Local Economy and Government

SUBCOMMITTEE CHAIR	John Clarkeson	Executive Office of Energy and Environmental Affairs

ADVISORY COMMITTEE PARTICIPANTS:

Brian Fairbank	Jiminy Peak Mountain Resort / EOS Ventures
Nathaniel Karns	Berkshire Regional Planning Commission
Al Neiderfringer	The Travelers Companies, Inc.
Paul Neidzwicki	Cape Cod Commission
Wendy Northcross	Cape Cod Chamber of Commerce
Karen O'Reilly	Lexington Insurance Group
Robert Zimmerman	Charles River Watershed Association
Carl Spector	City of Boston

OTHER CONTRIBUTING MEMBERS:

April Anderson-Lamoureux	Executive Office of Housing and Economic Development
Andrew Backman	Department of Conservation and Recreation
Kathleen Baskin	Executive Office of Energy and Environmental Affairs
Rick Chandler	Department of Agricultural Resources
Ryan Christenberrry	Cape Cod Commission
Alan Clayton-Matthews	University of Massachusetts Boston
Gerald Condon	Department of Insurance
Amy Cotter	Metropolitan Area Planning Commission
John Dalzell	City of Boston
Douglas Fine	Department of Environmental Protection
Kurt Gaertner	Executive Office of Energy and Environmental Affairs
Priscilla Geigis	Department of Conservation and Recreation
Caleb Huntington	Department of Insurance
Jonathan Hyde	Massachusetts Office of Tourism
Angus Jennings	Town of Westford
Gerald Kennedy	Department of Agricultural Resources
Rick Mattila	Genzyme Corporation
Robert Mitchell	Executive Office of Housing and Economic Development
Eric Nakajima	Executive Office of Housing and Economic Development
Galen Nelson	City of Boston
Thomas Philbin	Massachusetts Municipal Association
Martin Pillsbury	Metropolitan Area Planning Commission
Vandana Rao	Executive Office of Energy and Environmental Affairs
Robert Ritchie	Department of Agricultural Resources
Melissa Stults	ICLEI-Local Governments for Sustainability
Heather Warchalowski	Department of Conservation and Recreation
Brad Washburn	Office of Coastal Zone Management

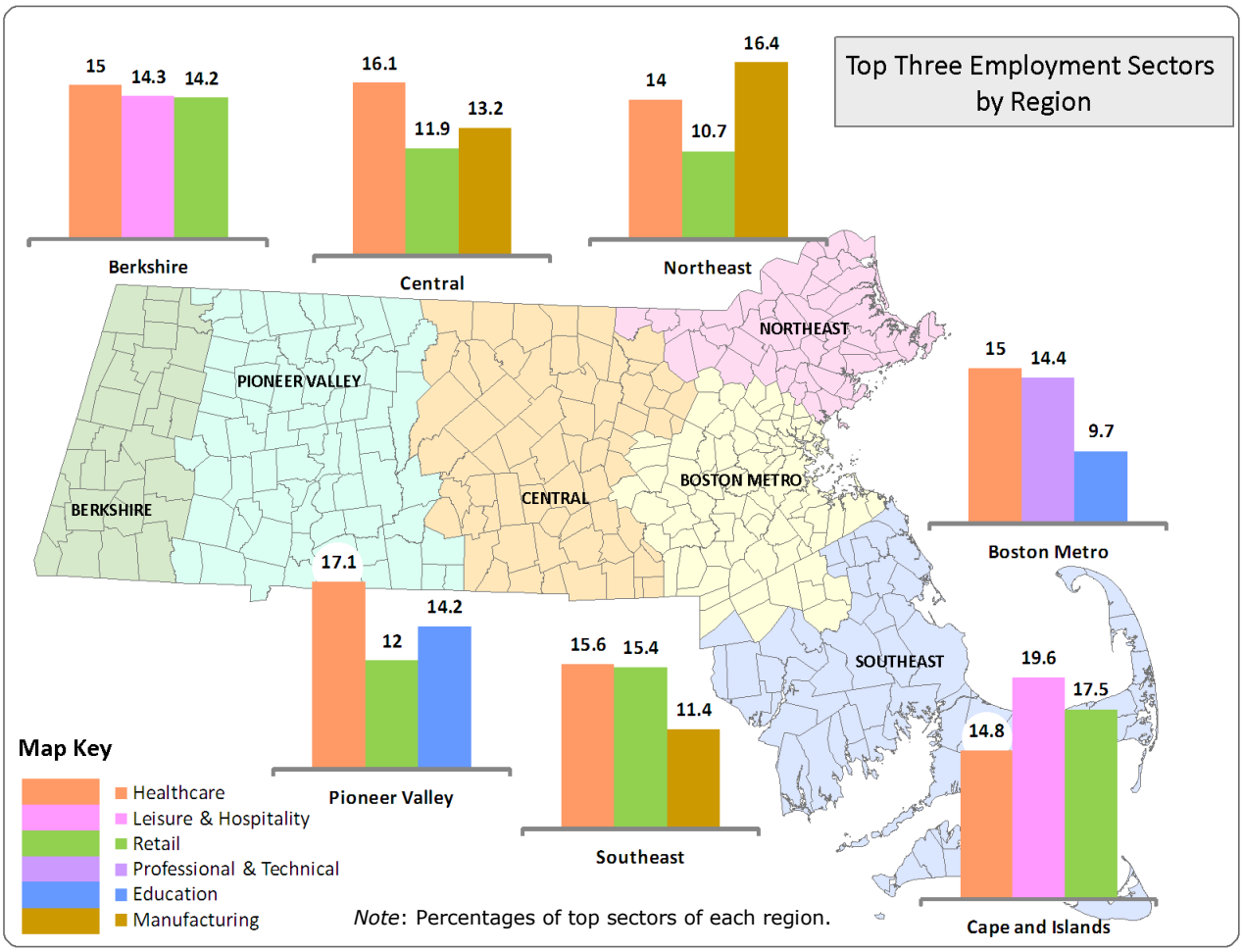
INTERNS: Craig Altemose, Cassandra Snow, Victoria Wolff, Kira Sargent

7 Local Economy and Government

Introduction

As climate change occurs, it will affect many of the features that make Massachusetts attractive—its cities and towns, job opportunities, historic sites and natural beauty. This chapter reviews how predicted climate change may affect key sectors of the Massachusetts economy and government. Some may be near-term impacts while others may create longer -range challenges. The sectors addressed in this chapter include weather-dependent industries such as agriculture, forestry, and fisheries; manufacturing such as computers, electronic equipment, fabricated metal, and machinery; and service industries such as real estate management, tourism and recreation, health care, and higher education. This chapter also provides an overview of the potential impacts on government and the services it provides, helping citizens to seek "safety, prosperity, and happiness" (Constitution of the Commonwealth of Massachusetts, 1780), and the importance of proper planning, development and siting in the land use section.

The Massachusetts Executive Office of Housing and Economic Development tracks economic activity in Massachusetts, dividing the Commonwealth into seven economic regions: Berkshire, Boston Metro, Cape and Islands, Central, Northeast, Pioneer Valley, and Southeast (See "Top Three Employment Sectors by Region" map below). In each of the seven regions, the health care industry is consistently among the top three employers. Retail ranks among the top three employers in six regions, manufacturing in three regions, and leisure and hospitality rank among top employers in two regions—the Cape and Islands, and the Berkshires.



Note: Percentages of top sectors of each region.

Education, among the top employers in Massachusetts, is concentrated in two regions, the Boston Metro and the Pioneer Valley (Nakajima, 2009).

Of the more than 6.4 million people living in Massachusetts, 5.18 million are considered to be of working age and 3.42 million are active in the workforce, either employed or seeking employment (Massachusetts Dept of Labor, 2009). The state ranks fifth in population density among the country's states and territories (U.S. Department of Commerce, 2000). In 2007, approximately 21.2 million travelers visited Massachusetts and spent over $15.1 billion (United States Travel Industry Association, 2008).

Overall Vulnerabilities

As discussed in Chapter 2, scientific research indicates that the state's climate will be warmer, the coastline will alter due to sea level rise, and fluctuations in weather extremes will bring more intense rain and ice storms, and greater heat intensity. Although all sectors will be affected by climate change, the impacts will be dependent on geography and the specific characteristic of a sector. For example, variable timing of precipitation events, as well as increased periods of heat and drought, are concerns for the agricultural sector and industrial processes that depend on water.

Should the water shortages predicted for the southwestern states intensify, Massachusetts may become an attractive place for water-dependent operations, including agriculture and manufacturing, resulting in an influx of new residents from the Southwest to New England—reversing a trend prevalent in the 1980s and 1990s. The business-as-usual scenario for 2035, as developed by NOAA, predicts that migration to the northern states will increase by 20 percent from 2020-2035 (NOAA, 2009). This will likely result in mounting pressure on water supply management strategies as the competition for water grows between human needs and ecosystem needs.

Economic Opportunities

Massachusetts is well poised to take advantage of the opportunities that climate change presents by developing new technologies for energy production and use, irrigation techniques, engineering design, and curriculum development. As an emerging economic sector, clean energy is expected to play an increasingly important role in the state's economic growth. In fact, according to a recent study (Clean Edge, Inc., 2010), Massachusetts has already become the leading state on the East Coast for clean energy innovation, investment, deployment, and jobs.

A Massachusetts Clean Energy Center survey of 471 local companies showed that more than 11,000 people were employed in clean energy at the end of 2010, up 65 percent since 2007. Some 3,500 people are employed in manufacturing of energy efficiency products, a growth of 20 percent since 2007, and the fastest growth (67 percent) is in energy storage. Employment in energy efficiency services has nearly doubled, from 1,000 in 2007 to 1,972 in 2010 in just the 69 firms surveyed, which represent only a fifth of energy efficiency services companies in the state. Jobs in solar manufacturing, installation, and services, meanwhile, have more than doubled during this same period.

In terms of future job potential, the clean energy sector will soon be the tenth largest employment group in the state. Renewable energy companies are the fastest growing firms in the state with an expected 30 percent job growth while energy efficiency firms are expected to grow by 25 percent, over three times greater than the next fastest

Wind Turbines at Ski Resorts: Energy Self-Sufficiency and Good Economic Sense

Ski resorts are constantly upgrading snowmaking capacity and efficiency in order to convert tremendous amounts of water into snow to supplement what nature provides. This effort is ongoing and will increase with predicted climate change of higher temperatures and reduced winter snow cover.

At Jiminy Peak in northwest Massachusetts, a 1.5 MW wind turbine installed in 2007 provides approximately 33 percent of the electrical demands of the resort annually. Winds blow strongest at the site during the winter when power needs are greatest for snowmaking, lifts, and night lighting. During these months, the turbine may provide as much as half of the electrical demand. Wind resource studies conducted by Jiminy Peak showed that the investment pay back was reachable within seven years and it would supply lower cost power for the long-term. The resort is currently investigating the installation of a second turbine.

Early in 2011, Berkshire East completed its wind energy project, making it the first ski resort in the world to be powered entirely by on-site wind generation.

December 2008 Ice Storm Affects Business

A dangerous combination of low pressure, moist air, and cold, powerful winds produced a violent ice storm over the Northeastern states in December 2008. Upstate New York, New Hampshire and northern Massachusetts were most severely affected. Thousands of local businesses were forced to close due to a lack of electricity, heat, sewage, and transportation of necessary supplies. Airports were closed and travel was shut down throughout New England. Delivery trucks could not reach their destinations, slowing commerce dramatically. The loss of sales in combination with property damage from falling branches and ice buildup caused small businesses to lose tens of millions of dollars.

emerging growth sector (Global Insight, Inc., 2007). The Advanced Biofuels Task Force estimated that development of non-food-crop-based alternatives to petroleum fuels could yield 2,500 permanent Massachusetts jobs within the industry by the year 2025, with another 3,700 jobs through indirect spending effects (Commonwealth of Massachusetts, 2008). Policies in the recently released Massachusetts Clean Energy and Climate Plan for 2020 (Commonwealth of Massachusetts, 2010) will help create 36,000 jobs in the State in 2020, including about 13,000 via transportation policies and 23,000 via policies to improve efficiency of energy use in buildings. The estimate for employment from in-state demand for renewable energy in Massachusetts in 2020 is 6,000 to 12,000 full-time jobs.

The potential integration of renewable energy and agriculture could result in the protection of farmland, while reducing or eliminating energy costs to farm operations and reducing the overall demand for fossil fuels. In agriculture, opportunities abound in the research and development of improved pest controls by private companies and academic research laboratories. The development of hybrid crops better able to withstand new pests emerging as a result of climate change could help increase crop resilience and protect farm income. Extended spring and summer growing seasons may improve crop yield and provide opportunities to expand crop varieties. They could also create an economic boon to warmer weather, tourist-based businesses.

In the health sector, climate change will affect human health worldwide. Massachusetts hospitals and universities could address these health effects in their research and teaching. In higher education, continuing research on climate change and adaptive strategies, improved engineering and design, and clean energy alternatives all provide additional opportunities for Massachusetts' economy.

Adaptation Strategies

In response to the vulnerabilities described above, the following pages outline key economy and government sectors and adaptation strategies that will continue to be evaluated and examined in response to potential climate change impacts.

Local Economy—Agriculture

Since colonial days, Massachusetts has maintained an agricultural economy through farming and forestry. Today, farming and agritourism remain central to the economy of many communities. While Massachusetts ranks 43rd among all U.S. states in agricultural production, it ranks 14th in net farm income per farm operation and fourth in net farm income per acre (USDA, 2007). Six of the state's counties are in the top two percent in the United States for direct sales to consumers.

There are approximately 6,000 farms in Massachusetts, with farmland covering approximately 14 percent of the land mass, or approximately 590,000 acres (USDA, www.agclassroom.org). Although many farms and much of the agricultural land base are devoted to major food crops such as apples, cranberries, vegetables, livestock and dairy products, greenhouse and nursery products such as flowers and ornamental plants are the leading sources of income for Massachusetts farmers. Specialty crops include apples, beans, butternut squash, cabbage, cranberries, corn, dairy products, potatoes, and pumpkins. Many of these are sold directly to consumers through farmers' markets, pick-your-own farms, agritourism, and farm stands.

Impacts and Vulnerabilities

Relatively small fluctuations in temperature, groundwater, seasons, and pest population dynamics can have dramatic short- and long-term effects on crops.

Increasing temperatures can extend growing seasons, bringing more income opportunities as well as increased operational expenses, including labor, irrigation, and other fixed costs. As higher temperatures and variable precipitation strain water resources, many agricultural enterprises may be challenged to reduce water use by altering irrigation practices. Irrigation demands, and their associated energy costs, may continue to rise as these climatic changes become less predictable. Agricultural water management will also be affected by potential competition from non-agricultural users such as expanding suburban development. With an increase in the potential for flood as well as drought,

increased capture and storage of water may be needed to provide a reliable and continuing source of water for irrigation-dependent crops.

Cranberries generate the largest gross revenue as an individual crop in the Massachusetts agricultural industry (USDA, 2007). With rising temperatures predicted, cranberry farmers are looking to bog management practices in New Jersey for lessons on maintaining successful operations in milder climates (Wick, 2009). With the cranberry production area primarily along the coasts, concerns are growing that sea level rise could cause saltwater intrusion into the groundwater and disrupt bog drainage in low slope streambeds.

Extreme and unpredictable weather patterns will also affect agritourism, a major growth sector. The number one impact on most Massachusetts retail farm sales is weekend weather because it affects the volume of customers coming both to the farm and to regional farmers markets. Climate change may also disrupt the balance between crop pests and diseases and the natural enemies or barriers that control them. Warmer climates enable more insect reproduction cycles in a season, resulting in potentially devastating effects such as the migration and spread of the Hemlock Woolly Adelgid into Massachusetts from neighboring states.

Lastly, a potential threat to Massachusetts agriculture is the sale of productive farmland for other development purposes. This is especially true in a climate change scenario where rising sea level can spur displaced populations from the New England coast and other "climate refugees" to migrate to undeveloped inland areas, such as agricultural lands.

Potential Strategies

General Agriculture Strategies

No Regrets Strategies

1. Assess vulnerable crops. Identify major crops and livestock likely to be affected by climate change, and practices that may mitigate these effects.
2. Establish technical assistance programs. Develop programs to keep the agricultural community informed about the impacts of climate change, how to adapt to the changing conditions, and alternative agricultural products.

Long-Term Strategies

1. Shift to alternate varieties or products. Evaluate means to alter farming practices and shift crop preferences to products better suited to greenhouse cultivation or new climate conditions.
2. Promote the concept of "Buy Local". Approximately 15 percent of the foods consumed in the state are Massachusetts grown. Increasing the consumption of locally grown products reduces the negative effects of shipping agricultural produce. For example, shortening the distance from production to consumption minimizes potential supply disruptions due to storm events, decreases shipping costs, and reduces greenhouse gas emissions from long-distance transportation.
3. Promote urban/community gardening efforts. Urban gardening may help to reduce the heat island effect in larger developed communities, increase consumption of locally grown products, and further reduce the negative effects of shipping agricultural produce.
4. Encourage expansion of improved storage facilities to hold and protect local produce during the growing season and after harvest.

Pest Control

1. Escalate pest monitoring efforts. Consider instituting monitoring and farmer education programs to identify and report harmful pests.
2. Conduct research and investigate use of pest controls for changing conditions. Integrated pest management, and the use of herbicides, fungicides, and insecticides will likely be needed to address pests not presently common in Massachusetts. Research by educational institutions and trade groups on organic strategies, as well as training in new pest controls may be needed to improve familiarity of best practices and alternative solutions to emerging pests.

Figure 8: ***Buy Local Groups*.**
Regional Buy Local Groups connect farmers to their surrounding communities and vice versa.
http://www.mass.gov/agr/massgrown/buy-locals.htm

Crops and Soils

No Regrets Strategies

Research soils, crop alterations. Enhance analysis of current soils and identify crops better able to accommodate shifting climate conditions.

Long-Term Strategies

Development of agricultural hybrids. Consider working to develop hardier hybrid crops to help protect crop resilience and, therefore, farm income. More attention may need to be paid to developing disease- and drought-resistant varieties. Research and development of hybrids can be ventures of private growers as well as educational institutions such as the University of Massachusetts Amherst. Private investors may fund research of commercially popular crops.

Agricultural Operations

No Regrets Strategy

Develop local alternative energy. Coordinate efforts between state agricultural and energy resources departments to enhance programs encouraging the development of local renewable energy on agricultural lands.

Long-Term Strategies

1. Adjust seasonal labor pools. Consider the need to shift from seasonal employment (college and high school students, migratory harvest workers) to alternate labor pools should longer warm seasons preclude labor pools dependent on academic calendars or shifting harvest seasons.
2. Expand crop planting to accommodate extended growing seasons, as feasible.

Water Use

No Regrets Strategies

Seek implementation of alternative irrigation practices and install water conservation practices to reduce vulnerability to water supply fluctuations. The U. S. Department of Agriculture's Natural Resources Conservation Services (NRCS) is a leader in helping Massachusetts irrigated farmland benefit from new lower water use technologies.

Long-Term Strategies

Increase use of storage. With the potential for extreme storm events and reduced summer precipitation, consider increased capture and storage of water to help increase crop reliability. Explore the option of providing farmers with financial incentives to invest in storage capacity.

Sea level rise impacts

Long-Term Strategies

Use improved LiDAR elevation data and information on sea level rise to guide cranberry growers who are considering relocation of vulnerable bogs.

Land Use Impacts on Agriculture

No Regrets Strategies

1. Continue efforts to minimize conversion of protected farmlands to non-agricultural uses.
2. Continue farm protection programs. Continue the Department of Agricultural Resources' Agricultural Preservation Restriction Program to preserve and protect farmland in collaboration with local land trusts and with matching funds from USDA (NRCS).

Local Economy—Forestry

More than 63 percent (nearly 3.3 million) of the state's total land area is forested (USDA, 2006). Timberland makes up 2.6 million acres much, of which is under private ownership (Butler, 2006). Concentrated in the central and western counties of Worcester, Berkshire, Franklin, Hampshire, and Hampden, Massachusetts timberland is capable of producing 20 cubic feet of wood per acre per year. In recent years, up to $845 million in economic activity has been generated annually from the Massachusetts forest products industry, which employs more than 24,000 workers. A total of 92 million board feet are harvested from Massachusetts forests each year, some of which are exported to other states. Massachusetts has 49 sawmills that produce approximately 49 million board feet of lumber each year (Reichel, 2009).

Most of the privately owned forests in Massachusetts are not managed for commodity use. It is estimated that Massachusetts forests support $15 billion in tourism annually. Forest-oriented wildlife recreation contributes about $1 billion to the state's economy, of which over a third is attributed to private forests. Active forest management helps to protect more than 350,000 acres of private forested open space, 50 percent more land than the state owns. If tree planting activities are increased to ameliorate the heat island effect in cities, mitigate urban

stormwater, and to sequester additional carbon, the increased need for saplings and trees will benefit the state's $2.6 billion nursery industry, the largest component of the Massachusetts agricultural sector (Riechel, 2009). Forests and trees, in addition to their ecological value, provide climate and nutrient regulation, soil retention, stormwater mitigation, heat island reduction in cities, and natural filtration of drinking water supplies.

Impacts and Vulnerabilities

Shorter and milder winters can disrupt seasonal schedules foresters rely upon to harvest timber and other forest products on tracts of land where frozen ground is preferable for operating harvesting equipment. Overall productivity may be reduced since operating harvesting equipment in mud is costlier. Warmer temperatures will also impact the time frame during which certain timber harvesting can be conducted—to take into account other ecological considerations such as wildlife species migration and nesting. Warmer temperatures can directly alter the value of forest products by causing an increase of stain in the wood from its sap. This stain, or discoloration, affects the grade of wood and may diminish its market value. More intense rainstorms will increase the costs of erosion control, requiring larger culverts on harvest sites.

Higher temperatures will disturb certain tree species, including spruce, hemlock and sugar maple, and alter the reproduction season of some rare species. Mortality may be much higher in young trees since they are less prone to survive heat and water stress, insect and fungal pests. Warming and the unpredictability of weather patterns may change the window during which certain timber harvesting can be conducted without harming rare species. Increased temperatures and the shorter duration of cold and chilling periods may increase invasive pests and plant diseases, such as the hemlock woolly adelgid (Adelges tsugae), which is far more virulent in southern forests (see case study in Chapter 4). Warmer weather may decrease the ability of certain species to survive and lead to an overall reduction in forest growth in this region. Many southern tree species (including species such as oak and hickory found in the upland central hardwoods forest, the predominant forest type in Massachusetts) could potentially move northward in a warming climate.

Although a relatively small industry in Massachusetts, sap collection for maple sugar products totals about 50,000 gallons with an approximate current value of $2 million. This significant niche industry relies on a sustained springtime freeze and thaw cycles. Such cycles are expected to become less common, and any sustained warming trend will be troubling for maple sugar producers.

Finally, increased temperatures and a longer growing season can increase aeroallergens, potentially affecting foresters with respiratory conditions and allergies.

Potential Strategies

No Regrets Strategies

1. Assess vulnerable species. Identify forest types likely to be vulnerable to climate change, and practices that may mitigate these effects.
2. Provide technical assistance. Provide foresters with information and support services about how climate change may disturb forests, and impart skills and strategies for keeping forests viable.
3. Enhance carbon sequestration. As forests are a very significant carbon sink in Massachusetts, explore strategies that maximize sequestration. Strengthen and develop markets and industries that use harvested wood in long-term products that store the carbon removed.

Short-Term Strategy

Reevaluate current harvest and natural regeneration practices. Research, educate, and develop incentives to encourage forestry practices that foster regeneration of vulnerable species (such as northern hardwoods) to perpetuate their many benefits. By regenerating species now, the growth of more mature trees will extend into periods when climate change impacts may increase in severity.

Local Economy—Fishing and Aquaculture

Massachusetts is one of the leading commercial fishing states in the U.S. In 2006, gross sales by the Massachusetts commercial fishing industry was $4.4 billion (U. S. Dept of Commerce, 2006), supporting 83,000 jobs in the state. This revenue includes not only products brought to the pier (landings) but also related sales and employment through processing and transport operations. The industry delivers a broad range of products including scallops, cod, flounder, haddock, lobster, goosefish, whiting, clams, crabs, hake, herring, pollock, squid, swordfish, and tuna.

The inland and shoreside industry is found mostly in New Bedford, Boston, Cape Ann, and Cape Cod, and produces hybrid striped bass, tilapia, trout, summer flounder, and other finfish. The marine aquaculture industry, found mostly on Cape Cod and the Islands, produces quahogs (hard-shell clams) and oysters, and small quantities of scallops, soft shell clams, and mussels.

Reported sales of marine shellfish topped $11.2 million in 2007. Altogether, inshore and intertidal shellfish such as soft shell clams, northern quahogs, blue mussels and oysters approximated 29 million pounds and exceeded $20 million (Murphy et al., 2009). In addition, the surf clam and quahog dredge fishing vessels landed $1.5 million and $1.4 million worth of surf clams and northern quahogs, respectively (Massachusetts Division of Marine Fisheries, 2008).

Total landings in 2008, not including dredge fisheries and large pelagic species (such as bluefin tuna), amounted to 530 million pounds, with a value of $383 million. Just over 10 million lbs of American lobster were landed in 2008 for a value of $44 million.

Of the New England states, Massachusetts enjoys the highest number of jobs sustained and total sales supported by recreational fishing, with over 6,080 jobs and $803 million in sales in 2006 (U. S. Department of Commerce, 2008). Recreational saltwater anglers took 4.5 million fishing trips and landed 15 million fish including striped bass, mackerel, summer flounder, cod, haddock, black sea bass, and scup. Saltwater anglers spend $800 million annually pursuing their sport, including $200 million from out-of-state participants. For freshwater fishing enthusiasts, more than 500 of Massachusetts' lakes, ponds, rivers and streams are stocked annually with trout, bass, herring, salmon and many other varieties.

Impacts and Vulnerabilities

As the ocean absorbs carbon dioxide, its pH level drops and it becomes more acidic. This could reduce calcification, a process by which sea creatures create their shells and exoskeletons (Green et al., 2009). These changes would affect mollusks, crustaceans, and some plankton species important to the ocean food chain and to human consumption, leading to a significant impact on the multi-million dollar clam, scallop, finfish, and lobster industries. The species distribution will likely change with warming ocean temperatures and this will alter the abundance and availability of those species vital to commerce and the marine ecosystem. Many commercial fishermen

and lobstermen may need to harvest from other waters or change their target of harvest (Jansen and Hesslein, 2004). A change in the target harvest may then require a change of gear, incurring a considerable expense.

A recorded warming trend in the coastal waters of Southern New England since 1999 has been cited as one reason for the lobster stock in Buzzard's Bay and Long Island Sound to seek deeper waters. As a result, southern New England and New York face a recommendation under consideration by the Atlantic States Marine Fisheries Commission for a substantial cut in landings to protect the remaining population, including a potential five-year ban on lobstering to help restore depleted stocks. Lobster experts have concluded that continued elevated temperatures in the nearshore southern New England and Mid-Atlantic waters will result in a near abandonment of these historically productive areas by lobsters, resulting in a stock that is far smaller than seen in the late 20th century (See http://www.asmfc.org/).

Shellfish aquaculture takes place mainly in the tidal margins. Farmed beds need shallow tidal effects. Some species, notably oysters, require a mix of salt and fresh water for their full life cycles. However, climate change can cause low-lying coastal zones to flood as the sea rises. The resulting new beach or tidal flat areas may not be suitable for aquaculture, or they may not be available at all as the presence of seawalls, roads and other structures may prevent the creation of new shallow water habitats. A shift in the low-lying coastal zones may also threaten the nursery and feeding habitat of other valued fish species. As a result, stocks of bluefish, tuna, cod, haddock, and sea bass typically available for commercial and recreational anglers may be diminished.

Although aquaculture harvesters will incur less gear damage with less ice, overall yield could be affected with changes in food availability and harmful algal blooms (HAB's) such as "red tide". In New England, red tide is the term used to describe a population explosion or bloom of the toxic phytoplankton Alexandrium fundyense. Red tide is an annual occurrence in the Gulf of Maine with distribution and concentration dominated by nutrient availability and weather patterns, both subject to climate change. Shellfish concentrate the toxin, creating a public health risk if consumed, forcing the closure of

productive shellfish areas and affecting harvesters and wholesale and retail shellfish sales.

For freshwater fishing, temperature changes may threaten these fish species, with warmer water temperatures resulting in a reduction of dissolved oxygen in surface waters, which can stress fish habitat (Jansen and Hesslein, 2004).

Potential Strategies

No Regrets Strategies

1. Assess vulnerable species. Identify species likely to be affected by climate change and practices that may mitigate these effects. This could be done by state and federal agencies, in collaboration with academic researchers and trade groups.
2. Provide technical assistance.
   a. Provide the fisheries and aquaculture sector with information about how each sector might be affected by climate change, and with skills and strategies for keeping fisheries and aquaculture viable pursuits; and
   b. Provide research assistance to the fishery industry to assist with changes in harvesting processes and targeted fish stocks.
3. Conduct research to predict which species of fish might thrive in a changed ocean environment.

Long-Term Strategy

Invest in good science to understand changes in fish abundance, ensuring that fisheries management evolves over time to address changing conditions.

Local Economy—Manufacturing (Computers, Electronic Equipment, Fabricated Metal, and Machinery)

Massachusetts is home to many manufacturing companies, employing approximately 9 percent of the state's workforce, or about 300,000 workers. The biggest sectors, comprising 85 percent of total manufacturing jobs, include computers and electronics, fabricated metal, food processing, machinery, chemical, printing, plastics and rubber, transportation equipment, paper, and electrical equipment. The remaining smaller sectors include textile mills, furniture, and petroleum and coal.

Ninety percent of Massachusetts' businesses have fewer than 100 employees and 85 percent are classified as small businesses with 20 employees or fewer. Small businesses employ more than one quarter of the statewide workforce. Although small businesses typically make decisions with a three- to five-year outlook, many employers make decisions that affect their businesses over a longer term on matters such as the selection of facility locations. Larger investor-owned businesses use longer-term time frames when making decisions related to market and product development, particularly research and development.

According to the 2008 Milken Institute State Technology and Science Index (DeVol et al., 2008), Massachusetts was ranked as the top science and technology economy in the U.S. Expanding research of new energy sciences, building design, and infrastructure engineering in Massachusetts will help the manufacturing industry develop an increased resilience to climate change.

Impacts and Vulnerability

Heavier, harsher storms causing floods will likely have an impact on buildings, energy delivery and transmission, and transportation systems. Manufacturing operations in low lying areas may be exposed to increased inundation. More frequent and extreme weather events may disrupt the supply chain of businesses dependent on raw materials for production. Similar impacts may affect product delivery as firms rely more on speedy transportation of goods rather than stockpiling of large inventories, and they may also affect workers' abilities to get to their job sites. Rising temperatures will increase the need for climate control in the workplace. If water availability is affected by an increased variability in precipitation, water-dependent manufacturing industries will likely be strained.

Potential Strategies

No Regrets Strategies

1. Protect water as an asset.
   a. Continue to use market-based solutions to preserve water resources and conserve water;
   b. Encourage water storage, taking advantage of high rain periods to offset drought periods;
   c. Expand/promote opportunities for water recycling, including grey water;
   d. Explore opportunities to coordinate water treatment and energy generation. Locating power plants adjacent to wastewater treatment facilities could partially displace freshwater needs for cooling purposes; and

e. Seek to reduce water use in energy production by considering alternative technologies, since peak water use in energy production often coincides with periods of high heat and low water availability.

2. Encourage or incentivize conversion to more energy-efficient processes or local renewable energy sources to alleviate dependence on the grid and to protect from power disruptions that can occur during extreme weather events.
3. Support improvements to on-site stormwater management to mitigate heavier rains, especially at facilities in low lying areas.

Short-Term Strategy

Examine advantages of increasing inventory supplies and identify alternative materials and inventory suppliers to avoid delivery interruptions.

Long-Term Strategies

1. Encourage businesses to incorporate climate change impacts, particularly as data are refined to a sub-state level, into risk assessments and risk minimization strategies.
2. Consider long-term location alternatives that avoid or address the impacts of climate change.
3. Support building design modifications, such as electrical and HVAC systems, that withstand more frequent flooding and heat waves.
4. Consider altering operation schedules to cooler times of day.
5. Investigate alternate transportation routes, energy supplies, and communication systems for suppliers, customers, and workers to respond to evolving climate change impacts.
6. Establish partnerships with industry and government to facilitate technical assistance to businesses that are adapting to climate change.

Local Economy—Service Industries

This sector includes the insurance, financial services, real estate management, health care, higher education, and tourism and recreation sectors.

Health care and social services are the largest employers, with over 470,000 jobs provided statewide, contributing in excess of $30 billion toward the state's gross domestic product (GDP) annually. Massachusetts is renowned worldwide for quality health care and attracts an equally global clientele, with two hospitals ranking in the top ten facilities in the nation (Comarow, 2009). A number of hospitals statewide have been designated sole community provider status, offering area residents ready access to many state and federal health programs.

Approximately 200,000 employees in the insurance and financial management industries generate more than $33 billion annually for Massachusetts' GDP. At $47.1 billion, real estate management generates the most toward the GDP of any economic sector in Massachusetts and provides jobs for approximately 446,000 people.

Massachusetts is also known for the quality and variety of its educational institutions, attracting students throughout the year, creating approximately 310,000 jobs, and producing just over $8 billion in GDP.

Massachusetts is home to 20 national parks and historic sites; over 450,000 acres of state-owned forests, parks, greenways, historic sites, lakes, ponds, and reservoirs; and innumerable local parks and recreational venues, scenic seashores, harbor islands, riverfront areas, convention centers and resorts. Tourism is a significant economic driver that generated over $15 billion in direct spending in Massachusetts in 2007 (United States Travel Industry Association, 2008). Massachusetts residents account for one-third of the visits calculated in tourism industry reports, while travelers from out-of-state offer a larger overall contribution to the state's economic health, visiting longer and spending more. The state is a destination for domestic and international travelers throughout the year.

Impacts and Vulnerabilities

Due to the impacts of climate change, buildings in low-lying and flood-prone areas will become more vulnerable to flooding, and facilities may need increased cooling systems. The insurance industry's income is also dependent on sales and activities in other parts of the country, and not solely on Massachusetts, so climate change impacts in distant areas can have an economic impact on insurance companies headquartered in Massachusetts. Damage resulting from more extreme storm events will initially be borne by the insurance industry, but will ultimately be passed on to policy holders. Insurance payments could increase for flooded property, damaged crops, livestock, spoiled perishable food due to electricity outages, and heat wave-related health insurance losses.

Those working outdoors, in sectors such as construction, public works, and parks, may see a reduction in productivity during high heat days. Increases in overall summer temperatures and frequency of heat waves are expected to reduce or slow construction projects due to health and safety concerns for workers.

The SEC and Climate Change

According to the Securities and Exchange Commission's (SEC) interpretative guidance, companies should evaluate, for disclosure purposes, the actual and potential material impacts of environmental matters, including the physical impacts of climate change on their businesses.

Oceanfront and riverbank resorts may face inundation from rising seas and flooding. Changes in global ocean currents may contribute to stronger hurricanes, putting additional pressure on Massachusetts coastal areas, especially Cape Cod. Real estate values in low-lying areas may drop as the risk of flooding and associated insurance premiums increase. Insurance firms will likely seek higher premiums. The insurance industry can play a particularly critical role in providing disincentives to build or remain in high risk areas, such as coastlines that experience increased storm surges and sea level rise.

Others firms may leave the market, seeking better returns elsewhere. With the Security and Exchange Commission's rules requiring a company to identify the impact of climate change on business or legal developments, insurance companies are likely to pay particular attention to the level of impact risk in both their coverage and investment portfolios.

Should storm events increase, political pressure may mount to encourage additional public financing of these risks in an effort to keep insurance costs low, through government programs such as the National Flood Insurance Program (NFIP). These programs work to reduce flood damage through hazard identification and mapping, effective community floodplain management, and insurance protection for property owners through subsidized insurance premiums (Federal Emergency Management Agency). The result could be taxpayer funds expended to underwrite risky investments and activities in vulnerable areas and indirectly encourage development in flood prone areas.

In Massachusetts, the Fair Access to Insurance Requirements (FAIR) Plan provides insurance to property owners the private market does not cover. Funded by the 400 property and casualty insurance companies operating in Massachusetts, FAIR provides a safety-net of coverage and has become the leading underwriter on Cape Cod, with over 23 percent of the market. Increasing risk in coastal and inland low-lying areas from more frequent and harsher storm events may not only lead to diminishing coverage by traditional insurance companies, but also a burden on FAIR and NFIP beyond their capacity to provide adequate coverage or to remain solvent in the face of a catastrophic event.

The health care industry is likely to see an influx of patients as well as impacts on operations (e.g., increased flooding risks or increased demand for interior cooling). Massachusetts will continue to be a destination for patients, making overall capacity a potential issue. However, beyond the capacity of the health care infrastructure, additional strain will be placed upon health care insurers. Should reliance upon health care facilities rise due to increases in vector borne and other diseases, the pressure on health care costs may further complicate cost containment measures and put even more pressure on insurance premiums. As many of Massachusetts' hospitals and universities promote research and teaching, they are poised to take on research and treatment of climate-related health impacts.

The tourist industry will potentially face a decline in water availability. Many hotels have already adopted conservation measures to reduce water use and associated costs.

The need to seek relief from heat may increase popularity of recreational activities, such as beach and waterfront activities. Climate change may result in a longer warm weather tourist season, but the associated increases in operation budgets will have to be sufficient to make the extended season economically viable. With a longer tourism season, employers may need to shift from their traditional seasonal labor pool comprising students and migratory workers to more permanent employees.

Warmer temperatures may limit traditional outdoor winter activities such as skiing, snowmobiling, and ice fishing. Less ice cover on lakes reduces the number of days available for ice fishing and increases the risk of accidents. To maintain a full ski and snowboard season, ski areas will need to increase snowmaking operations, thus increasing their operational costs and requiring more demand on water and power. While the fall foliage season attracts many visitors, rising temperatures will also put the colorful sugar maple at risk (Case, 2005).

Potential Strategies

No Regrets Strategies

1. Improve elevation data. To better predict and delineate areas of risk, use elevation assessment tools such as LiDAR to help inform decisions on siting.
2. Provide outreach and educate public and private employers about Occupational Safety and Health Administration requirements regarding employee protections in times of high heat.
3. Increase emergency preparedness for cold weather accidents.
4. Evaluate the impacts of the true cost of risk over time, and consider revising mortgage banking formulas to better reflect the risk. The mortgage qualification process currently takes only the first year of insurance premium into account, rather than the likely rise in a premium due to an increasing risk scenario over time. Alternate pricing strategies, such as a three-year rolling average of insurance costs to forecast future premiums, may produce better lending evaluation criteria when reviewing mortgage applications for both commercial and residential borrowers.

Short-Term Strategies

1. Continue to promote and enhance water conservation efforts to reduce occurrences of water shortages.
2. Increase and expand the focus on emergency preparedness, particularly in areas predicted to experience the greatest impacts.
3. Assess the ability to address health care capacity needs in potential areas of flooding, extreme heat, or poor air quality. Establish alternatives to avert temporarily overwhelming local health care facilities.

Long-Term Strategies

1. Improve science and research on prevention and cures of vector borne diseases that are predicted to increase with climate change (See Chapter 5 on Health and Human Welfare for more information).
2. To address potential changes in seasonal labor pools due to longer warm weather climate,
   a. develop new labor pools for tourist attractions through broadened training opportunities and outreach; and
   b. consider altering staff deployment and staff funding to tourist sites of consistent high use.
3. Encourage employers of outdoor workers to shift work schedules to cooler times of day whenever possible, including possibly extending break periods at midday to avoid times of highest heat.
4. Evaluate benefits and consequences of altering snowmaking strategies at enterprises dependent on snow cover, by making more snow during colder weather and stockpiling snow for later use.
5. Reevaluate the Federal Emergency Management Agency's (FEMA) role in providing insurance in vulnerable areas to improve alignment of potential risks of development with climate change impacts.

Local Economy—Cultural Resources

Massachusetts cultural resources are an important part of the state's, New England's and the nation's unique cultural heritage. A variety of cultural repositories exist across the state, such as

- libraries, archives, historical societies, museums, and city and town halls, which house culturally significant objects such as literary collections, special and rare collections, manuscripts, historical archives, municipal records, and artifacts;
- historic sites or areas, such as Local, State, and National Historic Districts and archaeological sites yet to be studied;
- ethnographic resources, areas and objects with unique cultural meaning for specific ethnicities or population groups, such as Native American Sacred Grounds; and
- public recreational areas such as parks and beaches, which may also contain outdoor sculptures as well as historic artifacts.

Existing Resources

These resources are managed by a variety of governmental, private, and nonprofit organizations, such as the Board of Library Commissioners, the Massachusetts Archives, the Massachusetts Historical Commission, the Department of Conservation and Recreation, municipal governments, historical societies, museums, private boards, Native American Tribes, and other ethnic groups.

Impacts and Vulnerabilities

Many cultural resources are vulnerable to climate change because of their location and fragility. There are many specific climate change impacts on these resources:

- Sea level rise may flood sites in coastal floodplains;
- Rising temperatures may make it too hot to visit sites without climate control capabilities;
- Rising humidity may damage archives and library, museum, historical society, and

municipal collections and place increased burden on climate control systems;

- Increased precipitation and floods may completely inundate sites or damage the structural integrity of historic buildings, archives, libraries, museums, and historical society collections;
- Increased extreme weather events may damage fragile historic buildings, archaeologically and ethnographically significant sites, libraries, museums, archives and their contents;
- Changing growing seasons and rising ocean temperatures may affect culturally significant species—such as lobsters, cod, blueberries, cranberries, and sugar maples; and
- Ocean acidification may damage underwater archaeological sites along the continental shelf, including shipwrecks and Native American sites.

Potential Strategies

No Regrets Strategies

1. Structural reinforcement. Consider improvements to the structural stability, water drainage systems, and weatherproofing of culturally significant sites as part of capital improvement projects.
2. Incorporate climate change vulnerabilities and adaptation strategies into the decision-making process related to maintenance, structural reinforcement, studies and funding, relocation of threatened objects, and landscaping of cultural sites.
3. Investigate installation of year-round climate control capabilities, including natural site climate control capabilities such as tree cover and vegetation, and re-examine the thermal properties of buildings to increase resilience and reduce greenhouse gas production.
4. Prepare historic landscapes for drought by planting drought-resistant native plants to reduce water needs.
5. Cultural resource property managers may coordinate among themselves and with emergency management organizations such as Massachusetts Emergency Management Agency (MEMA), FEMA, and COSTEP-Massachusetts (Coordinated Statewide Emergency Preparedness) to assess resource vulnerability and develop plans for resilience.

Short-Term Strategies

1. Prioritize sites for study. Identify and focus research efforts on historical, archaeological, and ethnographically significant sites that are most vulnerable to sea level rise and climate change.
2. Maintain and develop emergency management plans in conjunction with MEMA and FEMA. Re-examine and strengthen existing or create new emergency management plans for cultural resources based on identified new potential impacts.

Long-Term Strategies

1. Consider enhancing monitoring and record-keeping of the type and extent of existing vegetation at cultural resource sites to monitor any effects of climate change.
2. Investigate developing and implementing a plan to digitally record as many artifacts, collections, and sites as possible, prioritizing by level of risk to damage or destruction.

Government

Government at local, state, and federal levels face many of the same challenges as other sectors, such as facility siting, energy use for worker comfort, health risks to employees, sea water infiltration into groundwater supplies, and transportation mobility issues. Collaboration between government, education, and business is vital to effective climate change adaptation.

General Impacts and Vulnerabilities

Harsher weather events can include flooding from rains or coastal storms, extended heat periods, and saltwater infiltration of water supplies. As greater exposure to such vulnerabilities is likely to increase, emergency preparedness will take on added importance.

Structures such as buildings, roads, bridges, and dams that exist along rivers, the seashore, and in other vulnerable areas are more likely to be impacted from sea level rise and storms. Low income and vulnerable populations will disproportionately suffer the effects of extreme events, be least-equipped to adapt, and likely rely more heavily on government for support and relief. Of great risk to local government is its fiscal vulnerability, as damage to private property due to climate extremes may result in a reduction of the municipal tax base, while at the same time call for an increase in services for vulnerable populations, emergency response, and public and private infrastructure maintenance upgrades or replacement.

Government often provides a vision and planning effort that precedes action (Heilbroner, 1992). The need to be ready for an uncertain future requires leadership and decision-making about infrastructure, land, emergency response procedures, and many other components of modern social interaction.

Government, however, cannot provide such leadership in a vacuum. By enhancing existing alliances with trade associations, the insurance industry, worker unions, and institutes of higher education, government can foster improved climate change readiness in its own service to constituents as well as to each economic sector.

Potential Strategies

No Regrets Strategies

1. Consider vulnerable populations during emergency planning efforts, including potential relocation options. This may include the following strategies:
   a. In the wake of extreme weather events, assist employees with alternate transportation to job sites;
   b. During temperature swings, plan to accommodate an increased demand for health and safety services; and
   c. Encourage good neighbor advisories and institute cooling centers during heat waves.
2. Continue, and enhance as necessary, maintenance efforts on roadways and bridges to avoid washouts and increase vegetation along roadways and bridge embankments to hold soils on sloping areas.

Short-Term Strategies

1. Continue sponsoring climate change data collection and research as budgetary constraints allow.
2. Research and develop new products and engineering strategies to build climate change resilience.
3. Evaluate and implement changes in procurement, grant criteria, engineering standards, building codes, and zoning, as precautionary measures to reduce vulnerability to climate change impacts.
4. Collaborate with trade associations and the insurance industry to develop specification improvements that ensure building and infrastructure designs are more resilient to climate change. Examine development of a building-and-design education curriculum that incorporates planning for climate change.
5. Consider possibly amending Chapter 41, Section 81D of the Massachusetts General Laws to require inclusion of a climate change impact assessment and establishment of mitigation strategies in community master (comprehensive) plans.
6. Incorporate evaluation of climate change impacts into Massachusetts Environmental Policy Act (MEPA) (required by the Massachusetts Global Warming Protection Act of 2008) and other permitting processes, as these could facilitate consideration of climate change impacts in the development/redevelopment process.

Long-Term Strategy

Target infrastructure funding to assist in redirecting development toward less vulnerable areas.

Government—Enhance Emergency Preparedness

Emergency preparedness resources have evolved over time based on the demands of past emergencies and storm events. The scope, magnitude, and frequency of historic emergencies have served as the basis for the design and development of our current emergency preparedness infrastructure. As noted, storm-related emergency situations are expected to become more frequent and intense, and, with changes such as sea level rise, many areas that previously escaped storm impacts will now be vulnerable.

For the purposes of this assessment, the public safety sector has been viewed through the lens of emergency management. Emergency management is divided into four phases: preparedness, response, recovery, and mitigation.

Existing Resources

The overall emergency management strategy involves all levels of government, with an overarching concept of one level of government supporting another, e.g., federal government supporting the states, and states supporting regional and local entities. Typically, when the emergency management capacity of a lower level of government is exceeded, support is requested and provided by the next higher level of government. This planning and implementation model has generally worked well and has been enhanced with the requirements established by the National Incident Management System.

Impacts and Vulnerabilities

Since September 11, 2001 and the major storm events that hit the Gulf Coast region in the last decade, emergency management professionals have recognized how easily and quickly response and recovery capacity can be exceeded at all levels of government. These lessons can serve as the starting point for enhancing future emergency management capabilities in order to respond to the increased frequency and intensity of extreme weather events expected from climate change.

Potential Strategies

1. Update MEMA databases and maps. During emergency response and recovery phases, MEMA serves as the state's emergency operations center (SEOC). The SEOC is the focal point for all agencies and organizations that provide response and recovery activities, as well as the information source for the Governor's Office during emergency situations. Recent storm events and exercises have revealed areas in mapping and information systems that need to be updated and enhanced. As these efforts move forward, the potential impacts from climate change should be factored into the scopes of work for enhancing these systems, which will include getting support from state agencies such as the Massachusetts Department of Transportation (MassDOT) and DEP.
2. Update the State Risk Assessment Inventory. Based on predicted increases in areas subject to flooding and coastal storm flowage (e.g., expanded "A" and "V" zones), the State Risk Assessment Inventory should include an accurate list of at-risk government facilities and resources.
3. Update the State Comprehensive Emergency Management Plan to recognize the potential for climate change to influence the severity and frequency of a range of natural and technological hazards (flood, severe weather, drought, water contamination, etc.). Update and revise hazard-specific annexes and plans, referencing mapping and technical data with regard to climate change research.
4. Expand the scope of the State Hazard Mitigation Plan. This plan is routinely updated and submitted to the federal government to support funding requests for various mitigation projects that enhance the preparedness of government/public facilities to withstand future storm events and reduce damage potential based on historic experiences. Future plans should consider factoring in expected vulnerabilities from climate change impacts. This may require federal approval to allow flexibility in Hazard Mitigation programs, since federal requirements are prescriptive and could limit hazard mitigation projects designed to address climate change impacts.
5. Design and implement coordinated education and outreach efforts to increase awareness of the cost savings and public safety benefits of hazard mitigation, enhanced preparedness planning, and other projects that will assist communities and state agencies with climate change adaptation. Assistance programs to help municipalities develop debris management plans comprise one of several areas where local officials need both education and technical assistance.
6. Continue assessment of emergency responses. Since extreme weather events are predicted to occur more frequently, it is important to ensure that various sectors (such as the energy sector) have the capacity to respond to these events. Emergency management plans should be updated to account for predicted climate change and impact on delivery systems should be evaluated. Maintaining a database of available equipment parts to facilitate sharing during an emergency, and increasing replacement budgets and material stock should be considered.
7. Increase capacity to address emergencies by facilitating greater cooperation and sharing of resources and expertise with the business community, forestry sector, and the tourism industry at a regional scale.
8. Continue assessment of emergency equipment, supplies, and evacuation facilities.
9. Practice the execution of communities' emergency action plans, involving local non-governmental organizations for support, staffing, and building constituent support.
10. Establish support mechanisms to ensure overall preparedness to meet increased demand on local public works and emergency response staffs due to more extreme weather events.

Government—Improve Planning and Land Use Practices

Difficult societal decisions lie ahead regarding options and alternatives for reducing risk to public infrastructure, private property, natural resources, and human safety and welfare. Public discussions and deliberations can be initiated now to develop criteria, set priorities, and establish or modify policies to determine where protection should be advanced and where managed retreat may be more prudent. Future risk and costs can be minimized for new development and redevelopment through the careful siting and inclusion of design standards that account for higher sea levels and more intense

storms and precipitation events.

Numerous planning and land use tools will be critical to addressing climate change. These tools should be used to engage the public, analyze and present data to guide policy making, and inform conservation and development plans. New or revised policies and regulations can assist in guiding infrastructure or other investments to desirable outcomes given anticipated climate change impacts. The intent of this section is to synthesize and summarize means of employing land use tools and techniques to address the many challenges of adapting to a changing climate. Strategies have been divided into three sections: those that a.) apply predominantly to new development, b.) address existing development, and c.) concern planning regulations and assistance. These strategies will continue to be investigated for feasibility.

Potential Strategies

New Development Strategies

1. Consider sizing infrastructure (such as pipes, culverts, rain gardens) to handle predicted storm events. Consider modifying existing standards within the Massachusetts Stormwater Handbook to better handle stormwater volumes reasonably expected as the climate changes with an emphasis on green infrastructure.
2. Seek to ensure that state investments in infrastructure and development projects (direct or indirect via grants, loans, tax incentives or other funding mechanisms) reflect potential climate change impacts, especially future risk projections. Consider incorporating future risk projections into program-level project selection criteria and in capital budget review by the Executive Office of Administration and Finance in order to properly assess impacts.
3. Examine utilization of state statutes and regulations to ensure that new buildings are sited and built in a manner that reduces their vulnerabilities to impacts of climate change, especially those in inland and coastal floodplains and other current and future threatened areas. Consider applying one or more of the following land use tools.
   a. Provide incentives and tools including funding, a robust technical assistance program, and complementary state policies to aid in the implementation of "no adverse impact" policies.
   b. Guide development of structures and infrastructure to areas unlikely to be eroded or flooded by more intense and frequent storms and/or predicted sea level rise.
   c. Apply a "no adverse impact" approach (see case study on StormSmart Coasts in Chapter 8) via statewide regulation.
   d. Explore mechanisms that proactively address migrating wetlands. Consider utilizing "rolling regulations" that facilitate wetlands or beaches to migrate inland as sea level rises. Rolling regulations provide an alternative to prohibiting all development in coastal areas, preclude coastal armoring, and facilitate sediment transfer.
4. Site and design development to preserve/restore natural hydrology. Facilitate restoration or creation of flood storage where feasible.
   a. Investigate applicability of low impact development (LID) strategies via potential state stormwater regulations;

   b. Provide incentives and tools including funding, technical assistance, and complementary state policies to aid in the implementation of LID site design and stormwater management regulations;
   c. Develop regulations and incentives to encourage development projects to restore or create flood storage;
   d. Develop incentives for landowners to return impervious surface to permeable surface, especially once the impervious surfaces are no longer needed (for example, parking for an abandoned mall); and
   e. Consider establishing a public revolving loan fund or tax credits to support and encourage retrofitting—brownfield cleanup fund may be a model.

Land uses that absorb more water

A school in Manchester, Massachusetts invested $1.2 million on artificial turf for its athletic fields. After receiving four inches over rain during 12 hours on a Thursday evening and Friday morning, the newly constructed rubber turf field was dry enough to play on Saturday. The field substance used allows water to absorb into the ground rather than running off as stormwater. The field's design helps to recharge groundwater naturally while keeping the field dry and ready to use. With an increasing number of high-intensity storms anticipated with climate change, investments that increase pervious surfaces could have the dual benefit of reducing flooding and replenishing aquifers.

Existing Development Strategies

1. Explore options for ensuring that, as sea level rises, vulnerable buildings and infrastructure are structurally prepared for storm events. Means to achieve these goals may include enhancement of the building code to the extent feasible. "Index" the code to scientifically-derived standards, consider applying flood hazard area regulations to "A" zones, and consider updating policies/ regulations/safety standards applicable to vulnerable structures not covered by the building code.
2. Evaluate the potential benefits of classifying coastal areas by "tier" based on degree of risk, extent of existing development and corresponding investment, sensitivity of natural resources, and other factors. Indicate for each tier the degree to which areas so designated could be addressed, including options such as:
   a. Protect from sea level rise, in which:
      i. coastal armoring/shoreline stabilization will be allowed in the form of traditional "hard" engineered barriers (with careful consideration of their impact on surrounding property and habitats); physical barriers where appropriate and feasible, particularly in areas where land and existing development is too important to lose (for example, the hurricane barrier in New Bedford); or "soft" measures—landscape flood mitigation such as extensive LID and preservation or creation of wetlands or coastal dunes to mitigate storms impacts;
      ii. infill development will be permitted;
      iii. structures/infrastructure will be rebuilt if damaged; and
      iv. flood resistant building and infrastructure measures will be employed.
   b. Left for "nature to run its course," in which:
      i. coastal armoring/shoreline stabilization is strictly limited or not allowed;
      ii. new buildings and infrastructure are limited or not allowed;
      iii. managed retreat and relocation policies/ programs are pursued;
      iv. buildings are to be removed if threatened or "substantially" (for example, 50 percent) damaged;
      v. expansion of existing development is tightly constrained; and
      vi. existing infrastructure is maintained, but not repaired/replaced if substantially damaged.
3. Develop and implement a protocol for each proposed tier that applies appropriate state and local planning, regulatory, infrastructure, investment, and other tools. Begin with a factual inventory that characterizes coastal locations by degree of risk, existing extent of development, environmental sensitivity, and other factors. Then

Figure 9: ***WasteWater Treatment Plant in Hull, MA: Simulated flooding around a critical facility from base flood plus 3.3 feet of sea level rise.***
Base flood (i.e., a 100-year flood) elevations taken from FEMA Preliminary Digital Flood Insurance Rate Map for Plymouth County (11-7-2008). Labels represent flood water depths measured from building foundation at ground level.
Source: http://www.mass.gov/czm/stormsmart/resources/hull_inundation_report.pdf

Massachusetts precedence for 'no-build' in dangerous coastal areas

When a landowner sued the town of Chatham for its refusal to permit construction of a new home in the town's mapped floodplain, Chatham defended its floodplain zoning bylaw intended to protect local people, property and resources. In 2005, the Massachusetts Supreme Judicial Court issued a landmark ruling that upheld the bylaw, citing reasonable public interest, stating that its enforcement was not tantamount to a taking and did not require direct compensation from the town. Further, the land retained more than a token value. Even though residential units could not be built on the land, various other uses including fishing and agricultural uses were allowed on the site. The town's right to enact regulations that ensure the safety of its citizens in the face of a hazardous landscape was upheld.

utilize this information as the basis to:

a. Engage in a classic planning exercise to engage stakeholders and produce a plan that designates tiers and selects appropriate land use outcomes for each tier. Implement the resulting plan through statute, regulations, policies, and programs as appropriate;

b. Perform a scenario-based risk assessment in which the probable impact of various adaptation actions are determined for various climate change and socio-economic scenarios. For each location, the most robust adaptation option will generally be the one that performs best in the majority of scenarios. As part of the analysis, gather stakeholder input on costs of various socio-economic scenarios and acceptable degree of risk; and

c. Undertake some other process to produce a plan that addresses coastal impacts of climate change.

Planning, Regulation, and Assistance Strategies

1. Consider assigning an agency the responsibility to gather and provide data, offer policy guidance, facilitate inter-agency coordination, and otherwise serve as an information provider on climate change and adaptation strategies in order to coordinate actions and guide plans, regulations, and investments.
2. Promote state, local, and other land conservation and development plans that reflect future climate change risk projections and that post-storm emergency response and decision-making plans are in place. Investigate the Statewide Hazard Mitigation Plan and local mitigation plans prepared for MEMA/FEMA to determine if emergency planning is adequately addressed and respond as needed. Assist regional planning agencies in the production of regional climate action plans that comprehensively assess risks, costs, and potential solutions for adapting to climate change. Work with and provide incentives for municipalities to integrate the appropriate regional climate action plan into master, open space, and other local plans in order to ensure that they address climate change preparedness, resiliency, and adaptation over a long-term horizon.
3. Incorporate evaluation of climate change impacts in MEPA and environmental permitting processes. Review (and revise accordingly) state permitting procedures and regulations for ways to consider climate change concerns such as requiring alternatives and impact analyses for development of current and future threatened properties.
4. Use climate change impacts information to help identify high-value land acquisition:
   a. preserving large unfragmented blocks of open space and connecting corridors to allow species to migrate with their habitat;
   b. protecting unregulated but vulnerable areas for conservation uses;
   c. conserving parcels just inland to allow coastal ecosystems to retreat as seas rise; and
   d. preserve agricultural soils and lands, especially near urban markets.
5. Investigate opportunities where local regulations (general, environmental, zoning, etc.) can minimize the impact of climate change. Provide robust financial and technical assistance and enhanced planning and land use tools in order to encourage and assist communities in the potential use of local regulations to, among other things:
   a. preserve large unfragmented open spaces and connecting corridors;
   b. consider potential future floodplain expansion in land use planning and direct growth away from floodplains and other vulnerable areas—this may include the use of some form of overlay zoning (either through the potential hybrid of existing floodplain designations or expansion of regulated flood zones to encompass the 500-year flood zone) to preserve high water "climate impact zones";
   c. concentrate development on portions of a parcel that are least vulnerable; and
   d. transfer development rights from areas at risk and properties that have been damaged by storms.
6. Investigate opportunities where local land use regulations and building codes can address the "heat island" effect. Encourage the implementation of local land use regulations (zoning, subdivision, etc.) and the adoption of state building code provisions that address heat concentration including:
   a. land use regulations governing impervious surface, tree, shading, street/building orientation, etc.;
   b. building code provisions on roofing materials, insulation, fenestration, etc.; and
   c. incentivizing white, if not green, roofs.

 The symbol signifies adaptation strategies that are also climate change mitigation actions.

REFERENCES

Butler, B., 2006. The Forest Resources of Massachusetts, 2005. A USDA Forest Inventory & Analysis Update. U.S. Department of Agriculture. U.S. Forest Service. http://www.fs.fed.us/ne/fia/states/ma/ma_summary_2005.pdf.

Case, C. F., 2005. Climate Change Could Sour U.S. Maple Sugaring. Christian Science Monitor, April 6. http://www.csmonitor.com/2005/0406/p11s01-sten.html.

Clean Edge, Inc., April 2010. A Future of Innovation and Growth: Advancing Massachusetts' Clean Energy Leadership. Prepared for the Massachusetts Clean Energy Center.

Comarow, A., 2009. America's Best Hospitals: The 2009-10 Honor Roll. U.S. News and World Report, July 15. http://health.usnews.com/articles/health/best-hospitals/2009/07/15/americas-best-hospitals-the-2009-2010-honor-roll.html.

Commonwealth of Massachusetts, Spring 2008. Advanced Biofuels Task Force Report. P. 20.

Commonwealth of Massachusetts, 2010. Massachusetts Clean Energy and Climate Plan for 2020. http://www.mass.gov/Eoeea/docs/eea/energy/2020-clean-energy-plan.pdf.

Constitution of the Commonwealth of Massachusetts, 1780. http://www.malegislature.gov/Laws/Constitution.

DeVol, R., A. Charuworn, K., Soojung, 2008. State Technology and Science Index: Enduring Lessons for the Intangible Economy. The Milken Institute. http://www.milkeninstitute.org/publications/publications.taf?function=detail&ID=38801155&cat=ResRep.

Federal Emergency Management Agency, National Flood Insurance Program Issue Summary. http://www.fema.gov/plan/prevent/fhm/index.shtm.

Global Insight, Inc., 2007. Massachusetts Clean Energy Industry Census. Massachusetts Technology Collaborative. http://www.cleanenergycouncil.org/files/Clean-Energy-Census-Report-2007.pdf.

Green, M. A., G. G. Waldbusser, S. L. Reilly, K. Emerson, and S. O'Donnell, 2009. Death by dissolution: Sediment saturation state as a mortality factor for juvenile bivalves. Limnology and Oceanography 54(4): 1048–1059.

Heilbroner, R. L., 1992. The Wordly Philosophers, 7th Ed. New York: Simon & Schuster.

Jansen, W., and R. H. Hesslein, 2004. Potential effects of climate warming on fish habitats in temperate zone lakes with special reference to Lake 239 of the experimental lakes area (ELA), north-western Ontario. Environmental Biology of Fish 70: 1-22.

Massachusetts Department of Labor and Workforce Development, 2009. Seasonally adjusted data for June 2009. Commonwealth of Massachusetts, Department of Labor and Workforce Development.

Massachusetts Division of Marine Fisheries 2008. Massachusetts Marine Fisheries 2008 Annual Report. Commonwealth of Massachusetts.

Massachusetts Department of Public Health, 2008. Massachusetts 2007 Population Age Sex Race & Ethnicity—Census Bureau Estimates. Commonwealth of Massachusetts Department of Public Health. http://www.mass.gov/Eeohhs2/docs/dph/research_epi/city_town_pop_estimates07.pdf.

Massachusetts Executive Office of Housing and Economic Development. Manufacturing. http://www.mass.gov/?pageID=ehedterminal&L=3&L0=Home&L1=Economic+Analysis&L2=Key+Industries&sid=Ehed&b=terminalcontent&f=mobd_key_industries_manufact_ind&csid=Ehed.

Murphy, D.C., W. Burt, J. K. Butner, C. Goudy, and C. Hollingsworth, 2009. Aquaculture situation and outlook report 2009: Massachusetts. NRAC Publication No. 103-2009.

Nakajima, Eric et al., 2009. A Framework for Action: The State Regional Economic Development Strategy. State and Regional Profiles. Executive Office of Housing and Economic Development, Commonwealth of Massachusetts. http://www.mass.gov/Ehed/docs/EOHED/Economic_Framework/Framework_State_&_Regional.pdf.

National Oceanic and Atmospheric Administration, 2009. Scenario for 2035: Long-term Trends, Challenges and Uncertainties facing NOAA. A Working Document for NOAA Planning.

Riechel, C., August 2009. Massachusetts Executive Office of Energy and Environmental Affairs, Division of Conservation Services. Personal communication.

U. S. Department of Agriculture. Agriculture in the Classroom. Massachusetts Agriculture in the Classroom. http://www.agclassroom.org/.

U. S. Department of Agriculture, National Agriculture Statistic Service. 2007 Census of Agriculture. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/index.asp.

U.S. Department of Agriculture. United States Forest Service, 2006. Highlights of the 1998 Massachusetts Forest Inventory. http://www.fs.fed.us/ne/fia/states/ma/mahilite98.pdf.

U.S. Department of Commerce, American Fact finder—Census 2000. United States Department of Commerce. http://factfinder.census.gov/servlet/GCTTable?_bm=y&-ds_name=DEC_2000_SF1_U&-CONTEXT=gct&-mt_name=DEC_2000_SF1_U_GCTPH1_US9&-redoLog=false&-_caller=geoselect&-geo_id=&-format=US-9|US-9S&-_lang=en.

U.S. Department of Commerce, National Oceanic and Atmopheric Administration, 2006. Fisheries Economics of the United States 2006. United States Department of Commerce. http://www.st.nmfs.noaa.gov/st5/publication/economics_communities.html.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 2008. Fisheries Economics of the United States 2008. http://www.st.nmfs.noaa.gov/st5/publication/economics_communities.html.

United States Travel Industry Association, 2008. The Economic Impact of Travel on Massachusetts Counties. United States Travel Industry Association, Washington DC, October 2008. http://www.massvacation.com/research/ec_imp_hist07.pdf.

Wick, Brian, May 2009. Cape Cod Cranberry Growers Association, Telephone communication.

Case Studies

December 2008 ice storm impacts on Business:

State of New Hampshire Public Utilities Commission, http://www.puc.nh.gov/Safety/safety.htm.

Trees in the Right of Way: Ice Storm Highlights Uncertainty, http://www.nhlgc.org/publications/item_detail.asp?TCArticleID=141.

Wind Turbine at a Ski Resort–Energy self-sufficiency and good economic sense!: Brian Fairbank, Jiminy Peak Mountain Resort. Personal communication.

Intense Rainfall impacts on the Tobacco Plant: Chandler, R., August 2009. Massachusetts Department of Agricultural Resources. Personal communication.

Securities and Exchange Commission: http://www.sec.gov/news/press/2010/2010-15.htm.

Massachusetts precedence for 'no-build' in dangerous coastal areas: Chatham Case Study from Massachusetts Coastal Zone Management's Storm Smart Coasts program. http://www.mass.gov/czm/stormsmart/resources/stormsmart_chatham.pdf.

Land uses that absorb more water: http://www.gloucestertimes.com/punews/local_story_209223803.html.

8 — Coastal Zone and Ocean

SUBCOMMITTEE CHAIR: Bruce Carlisle Office of Coastal Zone Management

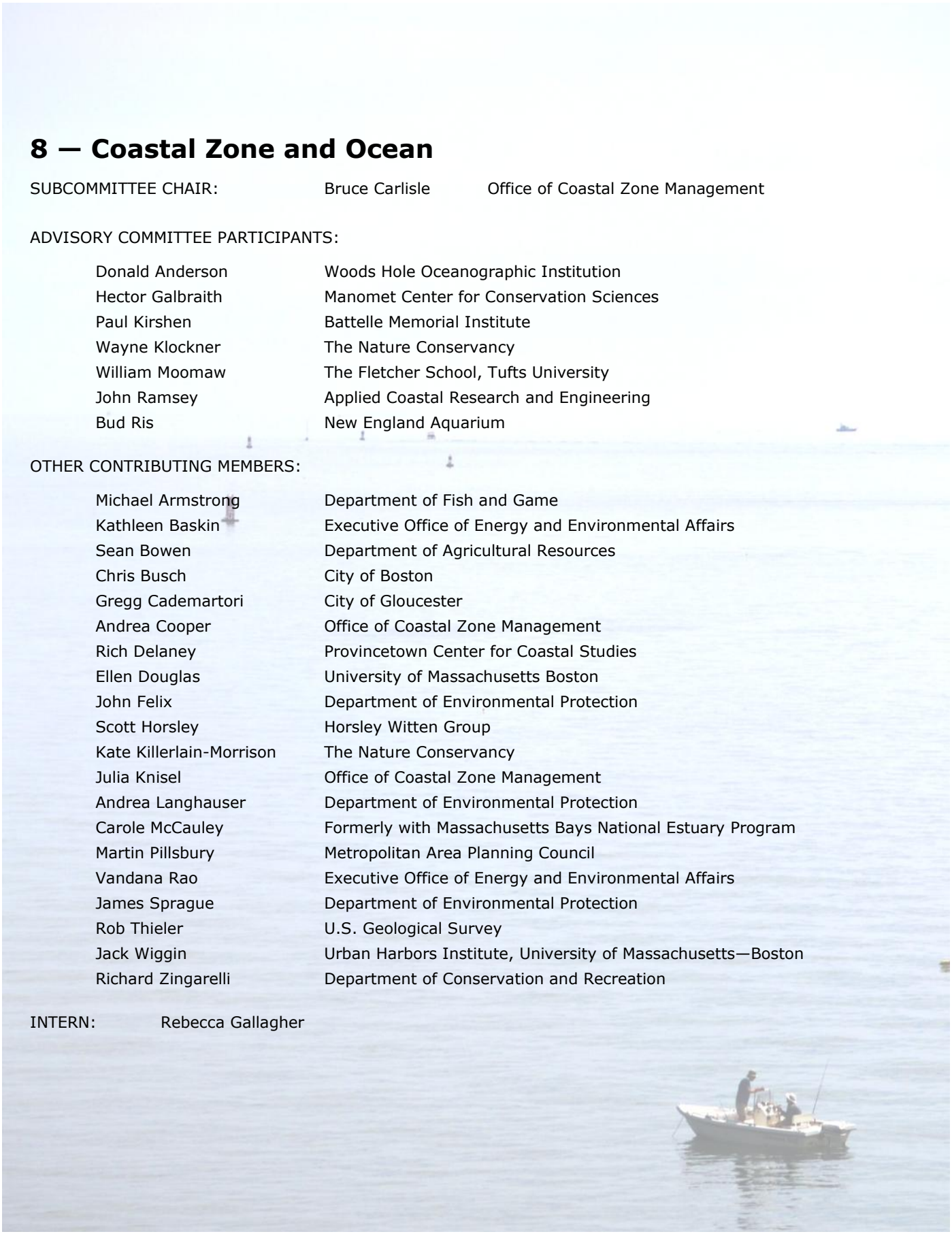
ADVISORY COMMITTEE PARTICIPANTS:

Donald Anderson	Woods Hole Oceanographic Institution
Hector Galbraith	Manomet Center for Conservation Sciences
Paul Kirshen	Battelle Memorial Institute
Wayne Klockner	The Nature Conservancy
William Moomaw	The Fletcher School, Tufts University
John Ramsey	Applied Coastal Research and Engineering
Bud Ris	New England Aquarium

OTHER CONTRIBUTING MEMBERS:

Michael Armstrong	Department of Fish and Game
Kathleen Baskin	Executive Office of Energy and Environmental Affairs
Sean Bowen	Department of Agricultural Resources
Chris Busch	City of Boston
Gregg Cademartori	City of Gloucester
Andrea Cooper	Office of Coastal Zone Management
Rich Delaney	Provincetown Center for Coastal Studies
Ellen Douglas	University of Massachusetts Boston
John Felix	Department of Environmental Protection
Scott Horsley	Horsley Witten Group
Kate Killerlain-Morrison	The Nature Conservancy
Julia Knisel	Office of Coastal Zone Management
Andrea Langhauser	Department of Environmental Protection
Carole McCauley	Formerly with Massachusetts Bays National Estuary Program
Martin Pillsbury	Metropolitan Area Planning Council
Vandana Rao	Executive Office of Energy and Environmental Affairs
James Sprague	Department of Environmental Protection
Rob Thieler	U.S. Geological Survey
Jack Wiggin	Urban Harbors Institute, University of Massachusetts—Boston
Richard Zingarelli	Department of Conservation and Recreation

INTERN: Rebecca Gallagher



8 Coastal Zone and Ocean

Introduction

Massachusetts' coastline and ocean are tremendous resources that have shaped the state's economy, history, and way of life. Today, unfortunately, these resources are threatened by a host of issues, including erosion of public beaches, costly storm damage of homes and businesses, habitat loss, pollution of waterways from land runoff, and the spread of invasive species. While work is underway to address these challenges, the focus is often based on a historic view of coastal and ocean environments. Climate change—with its resulting acceleration of sea level rise, potential increased frequency and intensity of storms, and shifts in ocean temperature, currents and chemistry—is altering these already dynamic environments, exacerbating coastal management challenges.

Through efforts in coastal hazards management, ocean planning, habitat restoration, fisheries assessment and management, and land protection, Massachusetts has taken many important steps and is poised to become a national leader in coastal climate change adaptation. To reduce and mitigate severe climate change threats to public safety, local and regional economies, marine and terrestrial habitats, and public and private infrastructure, a new focus is needed.

This chapter provides a general overview of the climate change vulnerabilities within the coastal zone and ocean "sector" in Massachusetts. It then focuses on three categories: (1) residential and commercial development, ports, and infrastructure; (2) coastal engineering for shoreline stabilization and flood protection, and; (3) coastal, estuarine, and marine habitats, resources, and ecosystem services. For each of these three categories, the chapter summarizes the existing resources and climate change adaptation efforts currently underway; discusses the vulnerabilities of these resources to climate change; and offers potential strategies for reducing risk and vulnerability and improving resilience to the evolving impacts of a changing climate.


AP Photo/Michael Dwyer

Overview of Vulnerabilities

Unaddressed, climate change will result in significant impacts to Massachusetts' coast and ocean waters. On the coast, modest changes in temperature can have major impacts on sensitive ecosystems, threatening biodiversity and ecosystem-based economies, such as fisheries, tourism, and recreation. Sea level rise will exacerbate impacts to development, infrastructure, and natural systems from erosion and storm damage. Impacts could include loss of life; extensive property damage; destruction of public infrastructure; release of sewage, oil, debris, and other contaminants; and loss of commercial and marine-related businesses critical to local, regional, and state economies.

Coastal salt marshes, barrier beaches, and floodplains are particularly vulnerable to rising sea levels because they are generally within a few feet of existing sea elevations. These areas also provide extensive recreational opportunities and significant environmental services, including providing habitat for many species, playing a key role in nutrient uptake, and protecting inland areas from flooding. In the ocean, temperature changes can influence ocean current strength, stratification of the water column, temperature and salinity levels, and nutrient and mineral transport—affecting the ecosystems and economically important species that depend on them. In addition, increased marine acidity levels will impact shell formation for certain species. The overall result of these changes for ecosystem and fisheries health will be significant.

Adaptation Strategies

Today, Massachusetts is already facing and endeavoring to manage the impacts of sea level rise, including increased erosion and storm damage. The resiliency of Massachusetts coastal and ocean ecosystems and economies—that is, their ability to accommodate impacts from both existing natural

hazards and future climate change—requires planning, collaboration, and action. With the many economic and environmental issues facing the state, addressing the additional challenges posed by climate change can seem a daunting, complicated, and expensive endeavor. However, by incorporating climate change projections into existing strategic, management, and fiscal plans, resiliency can improve. The result will be forward-thinking climate change strategies that could be built into land use plans, financial budgets and capital investments, regulatory processes, and similar implementation mechanisms. The following section contains possible strategies aimed at improving resiliency of Massachusetts' coasts and oceans. To more effectively convey a wide range of issues and suggestions, recommendations are organized under three categories within the Coastal Zone and Ocean sector. Strategies with similar elements have been consolidated.

Residential and Commercial Development, Ports, and Infrastructure

The coastal zone is densely developed with homes, businesses, roadways, docks, ports, and other infrastructure and facilities critical to local, regional, and state economies, but also highly vulnerable to storm damage and other impacts of climate change such as sea level rise. The built environment in the coastal zone, which constantly changes due to new development and redevelopment, presents a significant challenge for climate change adaptation.

Existing Resources

Massachusetts' coastal cities and towns are home to one third of the State's population and its coastal counties have more than three-quarters of the state's population. According to a U. S. Census Bureau estimate in 2007, coastal cities and towns with significant populations (>45,000 people) include Boston, New Bedford, Quincy, Fall River, Lynn, Revere, Plymouth, Weymouth, Peabody, and Barnstable. Within these and other coastal communities are an extensive number of residences, businesses, shopping centers and malls, industrial operations and the critical public and private infrastructure that supports this development.

A significant economic sector is coastal and marine tourism and recreation—which includes recreational fishing and boating—with an annual output of $8.7 billion in 2004. Another important sector to the marine economy is the commercial seafood sector—comprised of fishing and fishing supplies, marine aquaculture, seafood processing and wholesaling, and retail and food service seafood sales—whose value in 2004 was $1.6 billion (Donahue Institute, 2006).

Massachusetts Coastal Economy

The total output of the Massachusetts coastal economy is approximately $117 billion, or 37 percent of annual gross state product. The coastal zone economy directly employs over 1 million people, representing close to 37 percent of employment in the state.

Many resources already exist to reduce risks to development in the coastal zone. Massachusetts has statutory and regulatory programs that govern the siting and design of new construction and redevelopment, including the Massachusetts Environmental Policy Act (MEPA), The Public Waterfront Act (MGL chapter 91) and the Wetlands Protection Act. Environmental variation driven by a changing climate may necessitate modifications to these policy tools. Certain Massachusetts General Laws (e.g., Zoning Enabling Act, Wetlands Protection Act, Subdivision Control Law, and the Septic System Regulation-Title V) grant powers to municipalities to guide siting and design for growth. Local officials rely on Flood Insurance Rate Maps, the state Smart Growth/Smart Energy Toolkit, and funding via the Community Preservation Act to help guide siting and development.

Vulnerabilities

Development in the coastal zone is highly vulnerable to current and future impacts of climate change. Without adaptation, one can expect more extensive damage and loss of development associated with infrastructure and critical facilities due to severe erosion of coastal shorelines, overwash and

The Cost of Coastal Storms

The Massachusetts Hazard Mitigation Plan (2007) illustrates two significant coastal storms that hit Massachusetts in 1991, Hurricane Bob and the October nor'easter. These two events caused $49 million in damages to uninsured property and infrastructure (e.g., roads, bridges, public facilities, and public utilities). An additional $125 million was paid out by the National Flood Insurance Program (NFIP) in flood insurance claims. The following year saw another coastal storm that caused more than $12.6 million in damages to public infrastructure and 1,874 NFIP claims at a cost of nearly $12.7 million.

breeching of barrier beaches, inundation of coastal floodplains from sea level rise, increased storm surge, and flooding. Coastal communities that have been densely developed for decades already experience frequent and expensive flood damages. From 1978 to 2009, Scituate property owners received more than $49.6 million in National Flood Insurance Program (NFIP) claims. Scituate ranks number one in terms of flood damages and accounts for 17.6 percent of NFIP payments to policyholders in Massachusetts. The town of Scituate and other communities, including the city of Quincy, are actively working to help property owners elevate utilities and entire homes to reduce flood damages (Massachusetts Office of Coastal Zone Management, 2009). Other vulnerabilities include:

- Widespread damage of public and private development with limited or no relocation options;
- Impassable roadways and constrained access for emergency vehicles and personnel resulting in significant risk to public safety; and
- Inoperable wastewater and stormwater systems and associated public health concerns.

The funding and other incentives outlined in the previous section, while effective for short-term planning purposes, may not adequately consider longer-term of sea level rise or an increase in the intensity and frequency of storm events. Recent revisions to the State Building Code (780 CMR 120.G) strengthened existing standards for construction in floodplains and coastal dunes. Since many designs still do not address future inundation or migration of resource areas such as wetlands, however, new construction and redevelopment are likely occurring in areas that will erode and flood within the lifespan of these projects.

Potential Strategies

Adaptation strategies are necessary to reduce risk along Massachusetts' highly populated coast. An important and highly effective way to minimize threats to human health and safety, damage to public and private property, and preventable expenditure of scarce resources is to site new development and major redevelopment away from current and future vulnerable areas, including floodplains, zones subject to storm surges and wind-driven waves, and areas with high erosion rates. Additionally, by planning development to account for the future migration of important resource areas such as salt marshes, dunes, and areas subject to storm flow, the ability of natural systems to respond to changing conditions can be maintained. A proposed project located in an area that might be considered buildable today, may be undevelopable after weighing the projected costs against projected risk, factors such as increased sea level and flood frequency.

Climate change will result in greater storm damages to existing development and an increase in recurring storm damage to individual properties (referred to as "repetitive losses"). Difficult choices face Massachusetts regarding options for protecting the built environment and their potential conflict with existing property rights. Now is the time to start a public dialogue about the benefits, costs, risks, and resources needed to make informed decisions about where to target major investments to protect existing development. The analysis and assessment of risk management needs to be done at several scales and within different socioeconomic contexts, including state, regional, and local levels. In urban areas with large populations—especially those that are environmental justice communities—implementation of highly engineered structural protection measures will likely be a high priority for extensive public infrastructure and private development. Other areas may be able to reduce risk through approaches involving less engineered

Coastal Zone Management's StormSmart Coasts

Like other New England states with "home rule" government, many land-use decisions in Massachusetts are made at the local level. For coastal communities, this means grappling with the impacts and effects of erosion, storm surge, and flooding problems, which are being exacerbated and accelerated by global climate change. To help communities address these challenges, the Massachusetts Office of Coastal Zone Management (CZM) launched its StormSmart Coasts program in 2008. CZM developed user-friendly tools such as fact sheets, case studies, smart growth planning strategies, legal and regulatory tools, and extensive technical materials. CZM also held a series of regional workshops to connect local officials directly with the program.

Then, in 2009, CZM began five StormSmart Coasts pilot projects with seven communities—Boston, Falmouth, Hull, Oak Bluffs, and the three-town team of Duxbury, Kingston, and Plymouth—to test drive local, proactive implementation of StormSmart Coasts tools. The results are successful, transferable coast-wide models and enhanced partnerships with regional, state, and federal agencies; conservation organizations; academia; and the private sector to better serve coastal communities in Massachusetts. For more information, see the StormSmart Coasts website (www.mass.gov/czm/stormsmart).

structural measures, such as Low Impact Development, or some combination thereof.

1. Analyze strategies for siting new development and redevelopment outside of projected vulnerable and future resource areas. Design new development and redevelopment projects according to risk projected over the project lifespan. This may be achieved by the following means:
   a. Continue to discourage and avoid siting in current and future vulnerable areas, such as floodplains, velocity zones, and areas with high erosion rates. Additionally, by planning development to account for the future locations of important resource areas such as salt marshes, dunes, and areas subject to storm flowage, the ability of natural systems to respond to changing conditions can be protected;
   b. Consider building on Executive Orders 149 and 181 (intended to reduce vulnerability and damage costs in floodplains and on barrier beaches); explore issuing an Executive Order that specifically directs state development and significant redevelopment, as well as state-funded projects, out of vulnerable coastal areas;
   c. Strengthen the alternatives analysis for

Figure 10: ***Projected Inundation at High Tide, East Boston—2100***
Shading indicates current areas of East Boston, Massachusetts, inundated at high tide in the year 2100 under low and high sea level rise (SLR) scenarios. The future elevation of high tide is based on the current elevation of Mean Higher High Water (MHHW) plus projected SLR. The low SLR scenario at 2 m (A) includes both regional SLR due to land subsidence and the low end of the range of eustatic (global) SLR projected by Rahmstorf (2007). The high SLR scenario at 3 m (B) includes both subsidence and the high end of the range of eustatic SLR projected by Rahmstorf (2007). On the right, the top inset shows areas near Constitution Beach and the bottom inset shows areas near Central Square, under the high scenario. Highest confidence in the delineation of the elevation exists for blue-shaded areas. Areas shaded with red and orange contain minor uncertainty (5%) due to the vertical resolution of the topography
Source: Map developed by Chris Watson and Ellen Douglas, UMass-Boston; Paul Kirshen, Battelle

development siting and design standards to identify, characterize, and avoid project risk and adverse effects associated with climate change impacts;

d. Develop Chapter 91 policy guidance to fully implement 310 CMR 9.37(2)(b)(2), which states "[In the case of a project within a flood zone]…new buildings for non-water-dependent use intended for human occupancy shall be designed and constructed to…incorporate projected sea level rise during the design life of buildings", in a manner consistent with predicted sea level rise stated in this report. Consider a change to the regulation to include all new development and any redevelopment considered significantly vulnerable;

e. Examine Wetlands Protection Act rules and/or policies for potential revisions that address predicted changes in spatial extent of coastal wetlands;

f. Promote the nationally recognized "No Adverse Impact" approach—advanced by the Association of State Floodplain Managers (2007) and underlying the Massachusetts Office of Coastal Zone Management's StormSmart Coasts program—that calls for the design and construction of projects to have no adverse or cumulative impacts on surrounding properties;

g. Consider expanding recent revisions to the State Building Code, with provisions that strengthen requirements for storm-resistant building designs, materials, and features;

h. Update coastal erosion and flood-hazard zones delineations, especially in areas that experience high velocity floodwaters and breaking waves, so that they incorporate projected rather than historic rates of sea level rise; and

i. Consider whether a rise in water table levels warrants changes to the Massachusetts Septic System regulations (known as Title V) to provide for additional protective separation distances for septic systems.

2. Decrease risk and repetitive losses to existing development by implementing the following strategies:

   a. Consider additional revisions to the State Building Code to expand the requirement for elevating new and substantially improved buildings above the base flood elevation in hazard areas beyond the "V" zone (velocity flood zone with wave heights >3 feet) in order to accommodate sea level rise. Examine expansion of this standard to Federal Emergency Management Agency designated "A" zones (wave heights <3 feet) in coastal areas.

   b. Consider incentives such as insurance cost reduction and hazard mitigation grants for communities that embrace climate change adaptation measures.

   c. Seek to reduce the number of vulnerable coastal properties through land acquisition from willing sellers in fee, or by conservation restrictions. Evaluate the use of Transfer of Development Rights, a smart growth technique that is currently in use, to direct coastal redevelopment inland. A potential scenario may include several components for further consideration such as:

      i. to promote the transfer, existing homeowners who agree to sell their rights and abandon a storm-damaged property could receive state and local tax breaks for rebuilding in an upland area, or could purchase municipally owned land appropriate for development at a below-market rate;

      ii. additional funding could be realized by encouraging coastal communities to adopt the Community Preservation Act and use the Community Preservation Fund for acquisition of properties at risk of storm events and sea level rise (high risk for development) that also have preservation or recreation value; and

      iii. pool resources of the state and other partners, such as non-profit land trusts, to acquire land and conservation restrictions in perpetuity within vulnerable coastal areas.

Freeboard is the height of watertight surface between a body of water and the lowest point of entry. The expense of incorporating increased freeboard into new structures is low, generally adding only about 0.25 to 1.5 percent to the total construction costs for each foot of added height.

   d. Consider a statewide rolling easements policy for existing development along the shoreline. These rolling easements are typically coupled with policies that prevent armoring of the coast. Similarly, require that reconstruction of buildings significantly damaged by storm events comply with new standards and delineations of erosion and flood-hazard zones.

e. Evaluate and update hazard mitigation, evacuation, and emergency response plans to address the changing conditions associated with new development and climate change, especially related to sea level rise and increased storm intensity and frequency. Make updates to these plans as refinements are made to climate change projections and development patterns change within a community, or at a minimum of every five years.

Hull Freeboard Incentive

The Town of Hull offers a freeboard incentive to protect the health and safety of its citizens, prevent property damage, and reduce the need for costly emergency services during storm events. For residential and commercial building elevation, or new construction projects, building department permit fees will be reduced by $500 (or by the cost of the permit, if lower than $500) if an elevation certificate is provided to verify the building is elevated a minimum of two feet above the highest federal or state requirement for the flood zone. If the base-flood elevation on the FEMA November 2008 draft map is higher than the current map, eligibility for the permit fee reduction will be based on the draft map.

Coastal Engineering for Shoreline Stabilization and Flood Protection

Public and private coastal engineering structures are designed to protect buildings, infrastructure, and other uses in the coastal zone by controlling shifts in shoreline positions and blocking floodwaters. Engineered beaches and dunes that introduce sediment into starved beach systems are also considered in this section. Future permitting of coastal engineering projects could include consideration of local and regional processes and conditions to better eliminate or reduce impacts from erosion, flooding, and long-term inundation.

Existing Resources

A variety of structures exists along the coast of Massachusetts to stabilize the shoreline and protect buildings and infrastructure from erosion and flooding. Coastal structures include bulkheads, seawalls, revetments, groins, jetties, and breakwaters, as well as hurricane barriers, and flood and tide gates. The State conducted a comprehensive inventory of publicly owned or managed coastal structures along the shoreline (Massachusetts Coastal Hazards Commission, 2007). Visual inspections by civil engineers resulted in the rating of bulkheads, seawalls, revetments, groins, jetties, and breakwaters according to their condition using a letter system, from excellent (A) to critical (F). Structures with critical levels of deterioration exhibit conditions such as section loss, cracking and undermining. These structures provide little or no protection from major coastal storms and require complete reconstruction to regain functionality. Each structure was also assigned a priority rating based on its condition and ability to protect buildings from erosion and flooding. Structures with a high priority rating may warrant emergency stabilization due to the presence of high-density residential dwellings or other critical structures and the potential for loss of life or property. The inventory provides critical information required to better manage these structures. Similar assessments will need to be conducted for coastal structures that are in private ownership.

Vulnerabilities

Impacts of climate change will affect the ability of coastal structures to resist major storm events and prevent damage due to erosion and flooding. Structures placed along the shoreline, largely in the 1940s and 1950s and prior to enactment of coastal management policies and regulations, have interrupted the natural process of sediment transfer. Many of these structures, which were not designed for projected future conditions, remain standing landward of narrow beaches and other sediment starved resource areas. Potential overtopping, undermining, and collapse of coastal structures by storm surge combined with higher sea levels are serious concerns. Because of limited functionality and these potential impacts, residential and commercial development, ports, and infrastructure will likely be more vulnerable in the future. Maintenance and future plans for coastal structures challenge the state, municipalities, and residents of the coastal zone and require new strategies.

Coastal shorelines shift continuously in response to a variety of factors. Wind, waves, tides, seasonal variations, human alterations, and sea level rise influence the movement of sand and gravel within shoreline systems. Developed coastlines that face east or northeast are particularly vulnerable to nor'easters, which are common winter storms in Massachusetts. These coastlines are typically dominated by erosion and flooding. Erosion rates often increase as a result of coastal structures such as seawalls and revetments, which cut off the supply of sediment to adjacent beaches and decrease their widths and volumes. Barrier islands in Massachusetts actively erode because of decreased sediment supply as well as inlet dynamics, changes in nearshore shoaling patterns, location and size of coastal structures, and other human alterations. Climate change will exacerbate these issues—higher sea

levels and future storm events will result in greater erosion and flooding impacts over time.

Potential Strategies

The assessment of vulnerable coastal areas will require a better understanding of sediment resources and transport. By incorporating current shoreline change rates and trends as well as additional wave run-up analyses, the delineation of flood and erosion -hazard areas can be strengthened. The armoring of the coast has interrupted natural processes that build and maintain beaches, and has contributed to sand deficits that exist on many Massachusetts' beaches today. There are limits to the effectiveness and availability of beach nourishment and there are difficult decisions to make regarding holding the line or retreating. Protection of individual properties will need to be balanced against other local concerns such as effects to abutting properties, safety of emergency responders, and community resource values. In some cases, large-scale approaches may be considered to preserve uses (such as water-dependent and marine industrial) that cannot be relocated or protected using traditional structures. Overall, it is important to evaluate the application, design, and placement of coastal engineering approaches. Strategies for consideration include:

1. Institute policies and regulations to improve assessment of local erosion and flooding, and evaluate design and placement of engineered approaches to manage these coastal hazards. New or revised state policies and regulations that address coastal erosion and flooding, particularly related to coastal engineering practices, would improve assessment and management of these hazards.
    a. Strengthen the delineation of erosion and flood-hazard areas by incorporating current rates and trends of shoreline change as well as additional analyses of the maximum vertical extent of wave run-up on beaches or structures. With additional resources, state agencies could acquire and update this information every five to ten years for effective management of risk, especially in a changing climate.
    b. Continue to advance use of soft engineering approaches that supply sediment to resource areas such as beaches and dunes in order to manage the risk to existing coastal development. Periodic nourishment with sand is essential to maintaining dry recreational beaches along many developed coasts.
    c. Adhering to provisions of the Massachusetts Ocean Management Plan, examine issuing a state policy regarding the mining of sediment from the seafloor to guide the use of sand and gravel resources from Massachusetts' tidelands, especially for nourishment of private beaches.
    d. Consider prioritizing placement of sediment on public beaches over offshore disposal. Management of sediment resources is a necessary component of the overall resiliency approach that will allow competing interests to adapt and coexist in the dynamic coastal zone.
    e. Conduct an alternatives analysis when replacing failing public structures that pose an imminent danger, and ensure review of the analysis by local and state environmental agencies. Assessment of the analysis should consider cumulative impacts and the No Adverse Impact approach.
2. Plans to replace or construct new coastal engineered structures could better incorporate local conditions and higher sea levels. Analyses of benefits and costs may support large-scale engineered, structural protection of areas that are highly-developed urban centers or have significant water-dependent and marine industry that cannot be relocated.

Coastal, Estuarine, and Marine Habitats, Resources, and Ecosystem Services

Massachusetts coastal, estuarine, and marine habitats—such as beaches, salt marshes, and bays—provide valuable environmental, social, and economic benefits. Such benefits or "ecosystem services" are the wide range of conditions and processes through which natural systems help sustain and fulfill human life (Daily et al., 1997). These include maintenance of habitat for fish and shellfish, storm surge and flood protection, nutrient cycling and pollution prevention, atmospheric and climate regulation, renewable energy sources (wind, waves, and tides), and recreational opportunities.

While it is impossible to put an accurate dollar figure on the value of coastal and ocean systems, targeted economic analyses point to the tremendous value of this sector. For example, the National Marine

RESOURCE	AREA (ACRES)
Coastal bank	2,112
Barrier beach	11,840
Coastal beach	5,376
Coastal dunes	11,712
Rocky intertidal shore	1,024
Tidal flat	18,944
Salt marsh	45,376
Submerged aquatic vegetation	19,392

Table 7. *Extent of coastal and estuarine habitats in MA*

Fisheries Service indicates that 32 percent of the commercial fish and shellfish collected in New England are directly dependent on estuaries and salt marshes (Stedman and Hanson, 1997). For New Bedford and Gloucester alone, value of the commercial fish and shellfish caught in 2010 was more than $346 million (MA DMF, 2011). In addition, the U.S. Army Corps of Engineers concluded that the flood control benefits of wetlands in the Charles River basin alone were estimated to be nearly $40 million per year in 2003 dollars (Schuyt and Brander, 2004).

Existing Resources

Massachusetts has over 4669 km. (2,900 miles) of varied coastline and over 5180 km^2 (2,000 $miles^2$) of estuarine and marine waters that include a vast array of habitats, flora, and fauna. Using digital wetland resource maps developed by the Department of Environmental Protection's Wetland Conservancy Program and distributed by MassGIS, an inventory of these resources was obtained, as shown in Table 7.

The State also has abundant bays, sounds, and other ocean habitats with various geologic settings, bottom types, depths, tide and current regimes, and biological interdependencies. For a comprehensive overview of the marine habitats in state waters, see the Baseline Assessment of the Massachusetts Ocean Management Plan (Massachusetts Executive Office of Energy and Environmental Affairs, 2009), which contains synopses of primary and secondary producers, benthic communities, fisheries resources, avifauna, marine mammals, and invasive species. Table 8 , taken from the plan's Baseline Assessment, lists some habitat features and their biological links.

Existing state regulatory programs have strong provisions to avoid, minimize, and—if necessary—mitigate the current, but not future, adverse effects of anthropogenic stressors. Recent advancements in protection include updates to the Massachusetts Wetlands Protection Act regulations and the state's Title V Sanitary Code, development of nitrogen loading standards through the Massachusetts Estuaries Project, and siting and performance standards that protect sensitive and unique habitats in the Massachusetts Ocean Management Plan (Massachusetts Executive Office of Energy and Environmental Affairs, 2009). State funding programs, including Coastal Pollution Remediation, Section 319 Nonpoint Source Pollution Competitive Grants, and the State Revolving Fund, provide significant state resources that leverage local funds to implement specific capital projects to address pollution from wastewater, stormwater, and nonpoint source runoff.

Vulnerabilities

Changes in air and sea temperature, precipitation, ocean circulation and flow dynamics, sea level, and storm patterns will have cascading effects on coastal, estuarine, and marine habitats and resources—affecting the ecosystem services they provide. The list below summarizes significant vulnerabilities that could have cascading effects throughout ocean and coastal habitats:

- increases in stratification (the separation in the water column into distinct layers by salinity and/or temperature);
- changes in nutrient availability, and shifts in primary and secondary production due to changes in temperatures, precipitation, fresh water inputs, and currents/circulation;
- changes in, and potential loss of, suitable habitat and critical life-stage support for ecologically important marine and estuarine species;
- shifts in location and productivity of important marine and estuarine species, with a potential decrease and loss of significant commercial and recreational fisheries due to shifts in suitable habitat;
- loss of commercial fishing and aquaculture revenue due to shellfish impacts from reduced shell formation and reproduction and growth rates, and increased shellfish diseases, pathogens, and harmful algal blooms;
- loss of inter-tidal estuarine marsh habitat caused

Habitat Features	Characteristics
Non-living Structures (Cobble/rocky/boulder/ledge bottom [not shell] often called "rock piles")	Many species use these bottoms due to their 3-dimensional structures, which provide shelter. Some species' life histories require this type of habitat (e.g., juvenile cod and lobster)
Living Structures (Submerged Aquatic Vegetation, kelp, and structure-forming invertebrates)	Many species use these types of bottom due to their three-dimensional structure, which provide shelter. Some species' life histories require this type of habitat.
Areas of Upwelling	Important to driving productivity by bringing in nutrients; may not be a major feature in Massachusetts but could be important on a local scale
Deeper waters (channels, depressions)	Protected from the direct effects of storm-induced waves and warming waters
Estuaries, river mouths	Turbidity front at freshwater-saltwater interface can influence productivity.
Shell habitat	Settling habitat for invertebrates, may provide shelter
Shallow waters (<5 feet/1.5 meters) Mud flats, Salt marshes	Critical nursery areas; mud flats are of high value to marine animals that live and feed in this substrate
Frontal boundaries	Represent important "edge" habitat for a wide variety of resident and migratory pelagic species
Tide rips	Smaller frontal boundary features; sport fishing species; variety of species utilize these features and are popular fishing spots
Mud bottom	Has potential to provide abundant forage; lower resiliency to recurrent impacts in cold/deep mud bottom

Table 8. ***Marine habitat features and some important characteristics***

by an inability of marsh accretion and soil formation to keep pace with rapid sea level rise, further compounded by limitation of opportunities for landward migration;

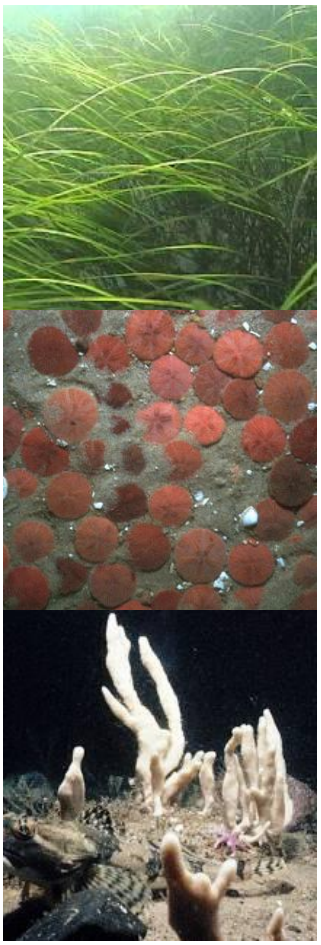
- degradation and loss of freshwater drinking water supplies through increased saltwater intrusion into groundwater aquifers;
- increase in adverse human health effects and degraded estuarine water quality due to increases in polluted run-off and combined sewer overflow events; and
- shell thinning due to increased ocean acidity in organisms with calcium carbonate shells (e.g., snails, clams, mussels, crabs, and lobsters), impacting both the ecosystem and economy.

Potential Strategies

The protection of land from future development through direct acquisition or conservation restrictions is one of the most straightforward and effective tools for climate change resiliency. To maximize the climate resiliency benefits from land conservation efforts by state agencies, evaluation and prioritization criteria for potential acquisition or restriction could include factors that examine the predicted future changes to the project area in terms of landscape, community, and habitat changes.

"Green" infrastructure—where habitat enhancements and natural systems are used instead of hard engineering for storm-damage prevention and other purposes—also promotes resiliency. The green infrastructure concept has strong connections to stormwater management and nonpoint pollution source control, where natural systems (such as vegetated swales, bio-retention cells, and green roofs) perform the water management functions of traditional engineered curbs, gutters, and pipes, but with significant natural benefits and less cost. Habitat enhancement projects that would serve as green infrastructure include: oyster or mussel reefs for storm surge attenuation, constructed wetlands for floodwater control and storm surge attenuation, planted coir fiber sills for erosion control and storm surge protection, and beach or dune nourishment for erosion control and storm surge protection. Shellfish aquaculture also provides ancillary benefits including nutrient (especially nitrogen) reduction when the cultured product is harvested.

As the marine and estuarine waters of the U.S. East Coast increase in temperature in response to global climate change, coldwater species are expected to move farther northward and species whose ranges have historically been farther south of Massachusetts will shift into Massachusetts waters and north of



Cape Cod. Fisheries managers will need the ability, tools, and information to change management measures in response to the redistribution of species. This will need to be accomplished at the interstate level involving the Atlantic States Marine Fisheries Commission, New England and Mid-Atlantic Fisheries Management Councils, and the National Oceanic and Atmospheric Administration. Future productivity of individual stocks may be significantly increased or decreased in response to climate change, habitat, secondary productivity, or ecosystems.

Historic harmful algal blooms, along with emerging data, suggest decadal cycles of occurrence. Climate change has the potential to alter abundance and distribution, disrupting natural, established cycles. At present, models focus on offshore waters. Higher model resolution in the nearshore will aid in the management of highly productive coastal and estuarine shellfish growing areas. As described above, while the general vulnerabilities of the coastal zone and ocean can be identified, the specific impacts and effects of changing estuarine and marine conditions are not well-known at this time.

Effective management requires sufficient and accurate information. Through this recommended strategy, the scope and focus of current monitoring, assessment and modeling efforts could be expanded to ensure that adequate ocean monitoring and observation capabilities exist in Massachusetts. This would provide sustained, high-resolution information at key locations for sea level, storm frequency and magnitude, salinity, pH, temperature, nutrients, biological community structure and size, currents, chlorophyll, and other parameters that will inform management of climate change impacts and trends. Strategies to be considered for implementation include the following:

1. Bolster land conservation efforts and account for changing landscape and natural communities, protect valuable ecological resources, and provide zones for migration:
   a. Protect land from future development through direct acquisition or conservation restrictions.
   b. Include factors that examine the predicted future changes to the project area in terms of landscape, community, and habitat changes in the evaluation and prioritization criteria for potential acquisition or restriction. Also, include tracts/habitat complexes at varying scales and geographic distribution in preservation targets. The ability of prospective areas to accommodate shifting natural communities and features like floodplains and seasonal wetlands will enhance natural resiliency.
   c. Identify the location of future habitats (and resource areas) through the implementation of predictive mapping and modeling, as a necessary step in the protection of these evolving ecosystems.
2. Improve resiliency of natural habitats, communities, and populations to climate change through habitat restoration, green infrastructure, and invasive species management efforts; design projects for future conditions. Healthier natural systems are better able to absorb and rebound from the impacts from weather extremes and climate variability.
   a. Ensure that projects account for future changes in the ecosystem, investments are justified given those predicted changes, and the project is designed and engineered for sea level rise and changes in hydrology.
   b. Promote resiliency through use of habitat enhancements such as constructed wetlands, oyster or mussel reefs (or other types of shellfish aquaculture), and for storm-damage prevention and floodwater control in lieu hard engineering solutions, where feasible.
3. Increase natural resiliency and reduce anthropogenic stressors through directed improvements in estuarine and marine water quality that minimize unavoidable impacts to habitat. This could be achieved via the following methods:
   a. Consider retreating and migrating wetlands, expanding floodplains, rising sea level and water tables, and increased inundation and flooding through program specific criteria, guidance, policies, or performance standards.
   b. Strengthen consideration of cumulative impacts as influenced by climate change at project planning levels, whether through MEPA review or the State Revolving Fund Loan Program Project Intended Use Plans.

Low Impact Development at Caldwell Farm—Building Smarter to Protect Natural Areas

Low Impact Development (LID) projects are designed to maintain natural drainage flow paths, minimize land clearance, and reduce impervious surfaces—all of which reduce stress on habitats and promote natural resiliency. The Caldwell Farm development in Newbury is an excellent example of how the interests of developers, realtors, and local officials can be brought together to create a "low impact development" that benefits all—including the homeowner.

A 66-unit housing project on a 125-acre site, Caldwell Farm was developed by C.P. Berry Construction Company, which incorporated LID techniques and the protection of open space to maintain 100 acres of the site as fields, forest, freshwater, and saltwater wetlands adjacent to the Parker River National Wildlife Refuge and an Area of Critical Environmental Concern (ACEC). LID techniques used in Caldwell Farm were cluster buildings, reduced road pavement width, and natural buffers to resource areas and grass swales for drainage. Caldwell Farms has received several national awards, including "the Best Overall Community" by the National Association of Home Builders in May 2007.

   c. Consider use of the No Adverse Impact approach, which calls for the design and completion of projects so that they will not have adverse or cumulative impacts.
   d. Consider development of No Net Increase approaches such as the nitrogen cap policy implemented by the Cape Cod Commission, which requires an offset of each increment of additional nitrogen load with some means of nitrogen removal for other nitrogen loads in the watershed.
   e. Maximize incentives, training opportunities, and requirements for Low Impact Development natural design and stormwater best management practices in local planning and regulatory processes to enable routine implementation of these proven smart growth tools, improving water quality and stormwater absorption and reducing flooding impacts.

4. Evaluate incorporating flexibility into fisheries management systems to accommodate species shifts. Expand biological surveys into estuaries, which is where climate change effects are anticipated to be especially pronounced. To avoid unnecessary burdens on recreational and commercial fisheries, fisheries managers could consider a move to a management system that incorporates more contemporary estimates of productivity and ecosystem processes, ensuring that targets are realistic and achievable. Ecosystem-based approaches that address cumulative impacts, establish cross-jurisdictional management mechanisms, and incorporate triggers and methods for adjustments based on evolving knowledge and information will provide significant institutional resilience to climate change.
5. Improve shellfish management and aquaculture by incorporating predictions of harmful algal blooms, marine pathogens, and rainfall. Obtain higher model resolution in the nearshore to aid in managing highly productive coastal and estuarine shellfish growing areas.
6. Increase monitoring, observations, and assessments to better manage resources and respond to critical shifts in conditions. Expand the scope and focus of current monitoring, assessment and modeling efforts including:
   a. Use acoustic mapping to provide base information necessary for determining bathymetry and seafloor hardness and roughness.
   b. Develop a better understanding of the spatial and temporal distribution and habitat needs of marine animals and plants.
   c. Track other important biotic components, especially endangered sea turtles, seabirds, major avifauna and bat migratory pathways, benthic communities of flora and fauna, certain pelagic fish, and areas of high trophic support (primary and secondary productivity and forage fish).
   d. Contribute to and support the development and operation of regional and local 'ocean observing system' infrastructure. Support and augment the few existing efforts that routinely collect such data, including the ocean observation system, whose buoys provide a range of information essential for navigation, safety, and oceanographic modeling and forecasting.
   e. Develop models of coastal hydrodynamics and inundation (coupled with biological and chemical models) to support scenario analyses of future conditions and to test hypotheses.
   f. Continue and augment other high priority baseline datasets, such as seafloor and water column temperature and salinity measurements, which can be used to track decadal, annual, and seasonal trends in salinity, temperature, and water column stratification. Improved measurements of waves and chlorophyll are also important for providing baseline information for modeling.

 The symbol signifies adaptation strategies that are also climate change mitigation actions.

REFERENCES

Association of State Floodplain Managers, 2007. No Adverse Impact in the Coastal Zone. Online: http://www.floods.org/index.asp?menuid=340.

Daily, G. C., S. Alexander, P. Ehrlich, L. Goulder, J. Lubchenco, P. A. Matson, H. A. Mooney, S. Postel, S. H. Schneider, D. Tilman, and G.M. Woodwell, 1997. Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems. Ecological Society of America, Issues in Ecology, Number 2, Spring 1997.

Donahue Institute, University of Massachusetts, 2006. An Assessment of the Coastal and Marine Economies of Massachusetts. Report I. Prepared for the Massachusetts Office of Coastal Zone Management. RFR#: ENV06 CZM09.

Massachusetts Coastal Hazards Commission, 2007. Preparing for the Storm: Recommendations for Management of Risk from Coastal Hazards in Massachusetts. Online: www.mass.gov/czm/chc/recommendations/chc_final_report_2007.pdf.

Massachusetts Emergency Management Agency and Department of Conservation and Recreation, 2007. Commonwealth of Massachusetts State Hazard Mitigation Plan. Online: http://www.mass.gov/Eeops/docs/mema/disaster_recovery/state_plan_2007_rvn4.pdf.

Massachusetts Executive Office of Energy and Environmental Affairs. 2009. Massachusetts Ocean Management Plan—Volume 2. Online: http://www.mass.gov/?pageID=eoeeasubtopic&L=3&L0=Home&L1=Ocean+%26+Coastal+Management&L2=Massachusetts+Ocean+Plan&sid=Eoeea.

Massachusetts Office of Coastal Zone Management, 2009. Case Study: Massachusetts Communities Reduce Storm Risk in Developed Areas. Online: www.mass.gov/czm/stormsmart/resources/stormsmart_quincy.pdf.

Schuyt, K., and L. Brander, 2004. Living Waters: The Economic Values of the World's Wetlands. World Wildlife Fund: Gland, Switzerland. Online: http://vinc.s.free.fr/IMG/wetlandsbrochurefinal.pdf.

Stedman, S. M., and J. Hanson, 1997. Habitat Connections: Wetlands, Fisheries and Economics in the New England Coastal States. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Other Useful References

Chen, C., R. C. Beardsley, S. Hu, Q. Xu, and H. Lin, 2005. Using MM5 to Hindcast the Ocean Surface Forcing Fields over the Gulf of Maine and Georges Bank Region. Journal of Atmospheric and Oceanic Technology 22(2): 131-145.

Eastern Research Group, 2010. Initial Estimates of Emissions Reductions from Existing Policies Related to Reducing Greenhouse Gas Emissions. Draft report to Climate Protection and Green Economy Advisory Committee.

Frumhoff, P. C., J. J. McCarthy, J. M. Melillo, S. C. Moser, and D. J. Wuebbles, 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

Hayhoe, K., C. P. Wake, T. G. Huntington, L. Luo, M. D. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. Degaetano, T. J. Troy, and D. Wolfe, 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Climate Dynamics 28:381-407, DOI 10.1007. Online at: www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

Holliday, M. C., and B. K. O'Bannon, 2002. Fisheries of the United States 2001. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics and Economics Division: Silver Spring, MD. Online: www.st.nmfs.noaa.gov/st1/fus/fus01/2001-fus.pdf.

Intergovernmental Panel on Climate Change, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Intergovernmental Panel on Climate Change, Fourth Assessment Report. Online: www.ipcc.ch.

Jiang, M. S., and M. Zhou, 2008. The Massachusetts Bay Hydrodynamic Model: 2005 Simulation. Massachusetts Water Resources Authority, Environmental Quality Department: Boston, MA. Report ENQUAD 2008-12. 58 p. Online: www.mwra.state.ma.us/harbor/enquad/pdf/2008-12.pdf.

Jones, C. P., W. L. Coulbourne, J. Marshall, and S. M. Rogers Jr., 2006. Evaluation of the National Flood Insurance Program's Building Standards. American Institute for Research: Washington, DC. Online: www.fema.gov/library/viewRecord.do?id=2592.

Massachusetts Aquatic Habitat Restoration Task Force, 2008. Charting the Course: A Blueprint for the Future of Aquatic Habitat Restoration in Massachusetts. Online: www.mass.gov/czm/habitat/docs/ahrtf_report.pdf.

Massachusetts Division of Marine Fisheries, 2011. Personal communication.

Massachusetts Office of Coastal Zone Management, 2002. Massachusetts Aquatic Invasive Species Management Plan. Online: www.mass.gov/czm/invasives/docs/invasive_species_plan.pdf.

Massachusetts Office of Coastal Zone Management. 2009. Raise Your Home, Lower Your Monthly Payments: Protect Buildings and Reduce Monthly Expenses with Freeboard. Online: www.mass.gov/czm/stormsmart/resources/stormsmart_freeboard.pdf.

Moser, S. C., R. E. Kasperson, G. Yohe, and J. Agyeman, 2008. Adaptation to Climate Change in the Northeast United States: Opportunities, Processes, Constraints. Mitigation and Adaptation Strategies for Global Change, Vol. 13, No. 5-6, 643-659, DOI: 10.1007/s11027-007-9132-3. Online: www.springerlink.com/content/d31622713717h428/?p=3a314135cad440a897a80f52d6b7918e&pi=2

Nixon, S. W., S. Granger, B. A. Buckley, M. Lamont, and B. Rowell, 2004. A one hundred and seventeen year coastal water temperature record from Woods Hole, Massachusetts. Estuaries: 27(3): 397-404.

Reback, K. E., P. D. Brady, K. D. McLaughlin, and C. G. Milliken. 2004. A Survey of Anadromous Fish Passage in Coastal Massachusetts—Part 1: Southeastern Massachusetts. Massachusetts Division of Marine Fisheries: Boston, MA. Technical Report TR-15. Online: www.mass.gov/dfwele/dmf/publications/tr15_anad_p1_intro.pdf.

Signell, R. P., H. L. Jenter, and A. F. Blumberg, 2000. Predicting the Physical Effects of Relocating Boston's Sewage Outfall. Estuarine, Coastal and Shelf Science 50: 59-72.

U.S. Climate Change Science Program, 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research (Titus, J.G., K.E Anderson, D.R. Cahoon, D.B. Gesch, S.K. Gill, B.T. Gutierrez, E.R. Thieler, and S.J. Williams). U.S. Environmental Protection Agency, Washington D.C., USA.

Wake, C., L. Burakowski, G. Lines, K. McKenzie, and T. Huntington, 2006. Cross border indicators of climate change over the past century: Northeastern United States and Canadian Maritime Region. The climate change task force of the Gulf of Maine Council on the Marine Environment in cooperation with Environment Canada and Clean Air-Cool Planet. www.gulfofmaine.org/council/publications/.

Case Studies

Massachusetts Coastal Economy: University of Massachusetts Donahue Institute, 2006.

The Cost of Coastal Storms: Massachusetts Hazard Mitigation Plan, 2007.

Coastal Zone Management's StormSmart Coasts: www.mass.gov/czm/stormsmart.

Hull Freeboard Incentive: http://stormsmartcoasts.org/uploaded_docs/HullPermitCreditFreeboard.pdf.

Low Impact Development at Caldwell Farm—Building smarter to protect natural areas: Massachusetts Coastal Zone Management staff write-up.

Photograph and Map Credits

State Agencies or Groups—

MA Clean Energy Center: page 57. **Department of Agricultural Resources**: front cover top. **Department of Conservation and Recreation**: page 3 bottom left, page 5 bottom middle, page 35, page 42, page 67, page 102, page 114. **Department of Transportation (MassDOT):** page 121. **Division of Ecological Restoration (DFW)**: page 4 middle right, page 62, **Paul Nguyen**, page 43. **Executive Office of Energy and Environmental Affairs (EEA)**: **Mark Breslow,** page 104; **David Cash**, page 92; interns **Noah Hodgetts and Seth Sheldon**, front cover middle, page 1 top left & right, page 3 top left & right, page 32, page 33, page 52, page 56 top left, page 61, page 64, page 71, page 87, page 100, page 107, back cover middle & bottom. **MassGIS**: page 1 top right. **MA Natural Resources Conservation Service**: page 2 bottom left, page 84 center & right. **Office of Coastal Zone Management**: page 2 top right, page 27. **Office of the Governor Photostream on Flickr®**: page 9, page 95. **Rapid Response Coastal Storm Damage Assessment Team**: page 4 top right, page 15, page 109. **MA Seafloor Mapping Cooperative**: page 7, page 94 right, page 117.

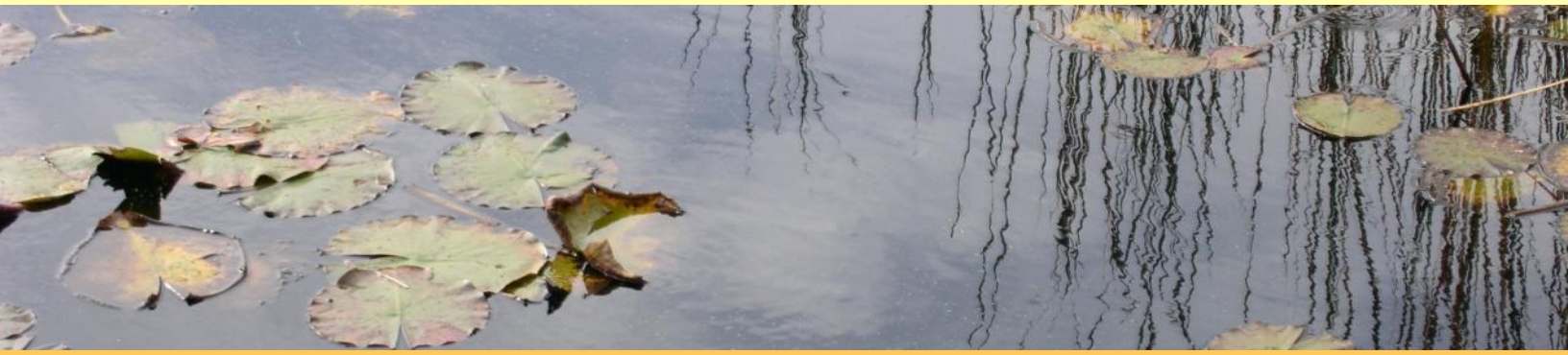
Other Photo Contributors—

AP Photo Service/Michael Dwyer: page 5 top left, page 108. **Berkshires Visitors Bureau**: page 96. **Charles River Watershed Association**: page 19. **The Chatham Times**: page 110. **Aleda Freeman**: page 5 bottom left, page 47, page 49. **GeoSyntec Consultants**: page 5 bottom right, page 67. ©**Stephan Gersh**: page 48, page 118. **Hazecam/Boston**: page 74. ©**Jonathan Hyde**: page 4 bottom right. **Jiminy Peak Mountain Resort**: page 89. **Massachusetts Audubon**: page 46, ©**Charlie Wyman**, front cover bottom. **Hugh Mattison/MMOC**: page 2 middle right. **Mount Grace Land Trust**: back cover top. **NASA**: page 1 bottom right. ©**Dirk G. Roggeveen/Nantucket Conservation Commission**: page 7, page 103. ©**Peter Shmiro**: page 55. **Town of Beverly**: page 3 bottom right, page 60. **Charter Williams**: page 44, page 84 bottom left, page 94 left. **U.S. Army Corps of Engineers**: page 68.

Maps—

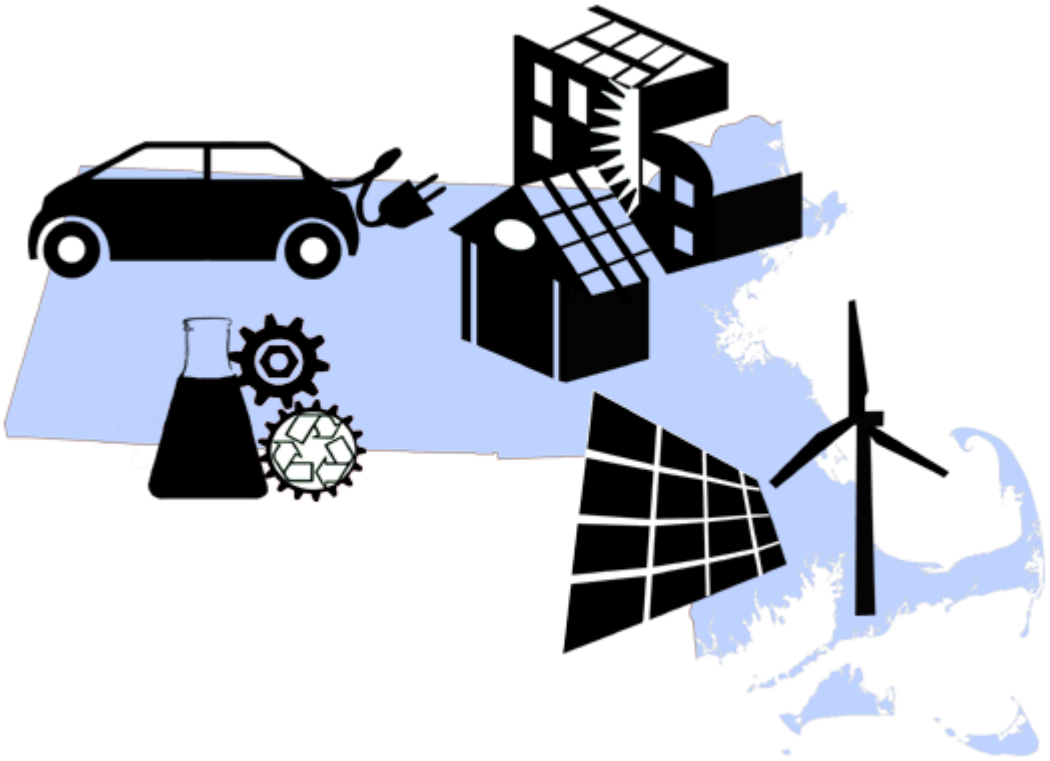
Buzzards Bay National Estuaries Program: page 73. **Kirshen et al.**: page 54. **Jane Pfister (EEA)**: pages 41, 45, 54, and 88.


B-148



B-149

Massachusetts Clean Energy and Climate Plan for 2020



A report to the Great and General Court pursuant to the Global Warming Solutions Act
(Chapter 298 of the Acts of 2008, and as codified at M.G.L. c. 21N)

Secretary of Energy and Environmental Affairs

Ian A. Bowles

December 29, 2010

Acknowledgements

CLIMATE PROTECTION AND GREEN ECONOMY ADVISORY COMMITTEE

Convener:
Ian A. Bowles
Secretary
Executive Office of Energy and Environmental Affairs (EEA)

Secretary's Designee:
David Cash
Assistant Secretary for Policy
EEA

Co-Chair:
Susan Avery, PhD
President and Director
Woods Hole Oceanographic Institute

Co-Chair:
Martin Madaus
Former President and CEO
Millipore Corp.

Julian Agyeman Ph.D. FRSA
Professor and Chair, Urban and Environmental Policy and Planning
Tufts University

Marty Aikens
Business Agent
International Brotherhood of Electrical Workers Local 103

Craig Altemose
Executive Staffperson
Students for a Just and Stable Future and Executive Director
Stop the Burning

Roger Berkowitz
President and CEO
Legal Sea Foods

Timothy Brennan
Executive Director
Pioneer Valley Planning Commission

Grace Chang
Vice President, Air Quality
A123 Systems, Inc.

Anne M. Finucaine
Vice President
Bank of America Corp.

John Fish
Chairman and CEO
Suffolk Construction Co.

Paul Gaynor
President and CEO
First Wind

Charles Harak, Esq.
Senior Attorney
National Consumer Law Center

Berl Hartman
Director
E2 New England

James W. Hunt III
Chief, Environmental and Energy Services
City of Boston

John Kassel
President
Conservation Law Foundation

Thomas King
Executive Director
National Grid

Kevin Knobloch
President
Union of Concerned Scientists

Penn Loh
Professor, Urban and Environmental Policy and Planning
Tufts University

Mindy Lubber
President
CERES

Thomas J. May
Chairman, President, Chief Executive Officer and Trustee
NSTAR

Carmichael Roberts
General Partner
North Bridge Venture Partners

James Ruberto
Mayor
City of Pittsfield

Una S. Ryan, Ph.D.,O.B.E.
President and CEO
Diagnostics for All

Laura Scott
Senior Vice President, Finance & Strategy
Gulf Oil Limited Partnership

Nancy Stevens
Mayor
City of Marlborough

Hernant Taneja
Managing Director
General Catalyst Partners

Steve Wofsy
Professor, Atmospheric and Environmental Science
Harvard University

Lisa Wong
Mayor
City of Fitchburg

CLIMATE PROTECTION AND GREEN ECONOMY ADVISORY COMMITTEE SUBCOMMITTEES

BUILDINGS AND ENERGY EFFICIENCY

CoChairs: Penni Conner (NSTAR) and Marcy Reed (National Grid)

Berl Hartman (E2), Betsy Boyle (CERES), Brad Swing (City of Boston), Charlie Harak (NCLC), replaced Amy Stacy with Nancy Doyon (National Grid), Jared Eigerman (Gouston & Storrs), Heather Henricksen (Harvard U.), Shanna Cleveland (CLF), Yakir Siegal (Suffolk Construction), Jeremy McDiarmid (ENE), Ed Mitchell (Legal Sea Foods)

State staff: Alissa Whiteman, Ian Finlayson & Frank Gorke (DOER), Ann Berwick (DPU), Marc Breslow (EEA), Mike Guigli (DPS)

COMMUNICATIONS

Chair: Karen Marinella Hall (Millipore Corp.)

Karen Wood (CLF), Emily Dahl (Nexamp), Walter Frick (Clean Energy Council), Ted Page (Captains of Industry), Craig Altemose (SJSF)

State staff: John Clarkeson, Bob Keough, Marc Breslow & Lisa Capone (EEA), Sarah Weinstein & Lee Dillard Adams (MassDEP), Susan Kaplan (DOER), Elizabeth Cellucci (DPU), Ned Codd (MassDOT)

ECONOMY-WIDE AND WORKFORCE

CoChairs: Penn Loh (Tufts) & Laura Scott (Gulf Oil)

Kathleen Freeman (NSTAR), Charlie Harak (NCLC), Seth Kaplan (CLF), Hemant Teneja (General Catalyst), James Hunt (City of Boston), Galen Nelson (Boston Redevelopment Authority), Craig Altemose (SJSF)

State staff: Ben Davis (DPU), Bill Lamkin (MassDEP), Vivek Mohta & Zazy Atala (DOER)

FORESTRY, AGRICULTURE, MARINE AND LAND USE CHANGE

Chair: Andy Solow (WHOI)

David Damery (UMass), Sue Reid (CLF), Steven Wofsy (Harvard U.), Timothy Griffin (Tufts U.), Dominique McCadden (Northeastern U, SJSF), Stephen Long & Laura Marx (The Nature Conservancy), Emily Russell-Roy (Pacific Forest Trust), Laura Hartz (Tufts U., SJSF), Jennifer Ryan & Heidi Ricci (MassAudubon)

State staff: Bob O'Connor & Celia Riechel (EEA), Ian Finlayson & Rob Rizzo (DOER), Saiping Tso, Gerard Kennedy & Hotze Wijnja (DAR), Will Space & Lee Dillard Adams (MassDEP)

INDUSTRIAL PROCESSES, SOLID AND HAZARDOUS WASTE REDUCTION AND MANAGEMENT

CoChairs: David Newman (Millipore) & Tom O'Rourke (NSTAR)

Steve Changaris (National Solid Waste Management Association, Mass. Chapter),

Shanna Cleveland (CLF), John Harland (Intel), Emanuele Ostuni (Nano Terra Inc.),

Rick Heller (Legal Sea Foods)

State Staff: John Fischer, Marc Wolman, Tom Bienkiewicz & Sharon Weber (MassDEP)

LOW CARBON ENERGY SUPPLY

CoChairs: Paul Gaynor (First Wind) & John Kassel (CLF)

Susan Reid (CLF), David Wilby (First Wind), Parker Weil (Bank of America), Ellen Angley & James Daly (NSTAR), Andy Chu (A123 Systems), Porter Hoagland (WHOI), Dan Bakal (CERES), Laura Scott (Gulf Oil), Nick Dahlberg (Boston U., SJSF), Joe Fitzpatrick (Atlantic Hydrogen)

State staff: Nathan Phelps (DPU), Dwayne Breger (DOER), Yaara Grinberg (fellow, DOER), Sharon Weber, Eric Fahle & Nancy Seidman (MassDEP)

TRANSPORTATION AND LAND USE PLANNING

Chair: Tim Brennan (Pioneer Valley Planning Commission)

Berl Hartman (E2), Penn Loh (Tufts U.), Laura Scott (Gulf Oil Limited Partnership), Andre Leroux (Smart Growth Alliance), Lisa Wong (City of Fitchburg), Rafael Mares (CLF), John Dalzell (Boston Redevelopment Authority), Carol Lee Rawn & Sharleen Leurig (CERES), Richard Heller (Legal Sea Foods), John Read & Vineet Gupta (City of Boston)

State staff: Marc Breslow, Catherine Cagle, Ned Codd, Victoria Maguire, Christine Kirby, Kurt Gaertner

STATE STAFF

STEERINGCOMMITTEE

David Cash, Assistant Secretary for Policy Executive Office of Energy and Environmental Affairs (EEA)

Laurie Burt, Commissioner, Department of Environmental Protection (MassDEP)

Phil Giudice, Commissioner, Department of Energy Resources (DOER)

Tim Woolf, Commissioner, Department of Public Utilities (DPU)

David Mohler, Executive Director, Office of Transportation Planning, Department of Transportation (MassDOT)

April Anderson Lamoureux, Permit Ombudsman, Executive Office of Housing and Economic Development (HED)

INTERAGENCY MANAGEMENT TEAM

Marc Breslow, EEA

Vivek Mohta, DOER

Ben Davis, DPU

Lee Dillard Adams, MassDEP

Jim Colman, MassDEP

Lucy Edmondson, US EPA, formerly MassDEP

IMPLEMENTATION TEAM

Marc Breslow, EEA

Ian Finlayson, DOER

Vivek Mohta, DOER

Jim Colman, MassDEP

Lee Dillard Adams, MassDEP

Lucy Edmondson, US EPA, formerly MassDEP

Bill Lamkin, MassDEP

Nancy Seidman, MassDEP

Sharon Weber, MassDEP

Ben Davis, DPU

Catherine Cagle, MassDOT

Ned Codd, MassDOT

Victoria Maguire, EOHED

POLICY DEVELOPMENT

Ann Berwick (Commissioner, DPU)

Maeve Vallely Bartlett (EEA)

Rich Bizzozero (OTA)

Amy Branger (MassDOT)

Dwayne Breger (DOER)

Janet Curtis (DOER)

John Fischer (MassDEP)

Eric Friedman (DOER)

Kurt Gaertner (EEA)

Thomas Gatzunis (Commissioner, DPS)

Mike Guigli (DPS)

Christine Kirby (MassDEP)

Audrey Lee (fellow, DOER)

Lawrence Masland (DOER)

Bob O'Connor (EEA)

Scott Peterson (MassDOT/CTPS)

Celia Riechel (EEA)

Mike Sherman (DOER)

Alissa Whiteman (DOER)

Marc Wolman (MassDEP)

CONTRIBUTORS

Kathy Baskin (EEA)

John Clarkeson (EEA)

David Howland (MassDEP)

Holly Johnson (MEPA)
Geri Lambert (MassDEP)
Marilyn Levenson (MassDEP)
Bob Levite (UMass Agricultural Extension)
Ann McGahan (MassDOT/CTPS)
Ann McGovern (MassDEP)
Gerry Palano (DAR)
Steve Petsch (Office of State Geologist)
Jane Pfister (EEA)
Susan Quinones (MassDOT)
Vandana Rao (EEA)
John Raschko (OTA)
Sue Ann Richardson (MassDEP)
Tom Riley (DPS)
Tom Witkin (DOER)
Sarah Weinstein (MassDEP)

INTERNS

Elizabeth Barthelmes (MassDEP)
Hilary Dennis (MassDEP)
Bailey DiOrio (EEA)
Jeffrey Kalmus (DOER)
Leslye Penticoff (EEA)
Mary Schnoor (DOER)

Consultants

Eastern Research Group: Paula Fields, Jason Veysey, Stacy DeGabriele, Robyn Liska, Scott Warner, Jan Connery, John Wilhelmi, Charlie Goff

Synapse Energy Economics: Bruce Biewald, Ezra Hausman, Kenji Takahashi, David White, Lucy Johnston, Patrick Knight

Cambridge Systematics, Inc.: Christopher Porter, Nathan Higgins

Abt Associates: Michael Fisher, Isabelle Morin, Dan Basoli

Stockholm Environment Institute-U.S.: Charles Heaps, Victoria Clark

Ventana Systems: Tom Fiddaman, Ron Suiter, Bill Arthur, Bill Kilpatrick (Real Ability)

Statutory Requirement

This report fulfills the requirements of Chapter 298 of the Acts of 2008, and as codified at M.G.L. c. 21N.

Section 4. (a) The secretary shall adopt the 2020 statewide greenhouse gas emissions limit pursuant to subsection (b) of section 3 which shall be between 10 per cent and 25 per cent below the 1990 emissions level and a plan for achieving said reduction.

Table of Contents

Executive Summary

A Clean Energy Revolution

Between 2007 and the end of 2010, solar photovoltaic (PV) systems installed and scheduled for installation in Massachusetts increased 20-fold – with jobs in solar manufacturing, installation, and services nearly tripling — while installed wind energy increased 10-fold. In that same time period, Massachusetts launched the most aggressive energy efficiency program in the country, with estimated savings of over $6 billion for residential, municipal, industrial and commercial customers and 4,500 jobs sustained or created.

This is not a vision of a possible future for Massachusetts. This is Massachusetts today.

It is in this context that the Executive Office of Energy and Environmental Affairs (EEA) presents the *Massachusetts Clean Energy and Climate Plan for 2020*. The Global Warming Solutions Act (GWSA, or the Act) of 2008 requires the Secretary of Energy and Environmental Affairs to establish a statewide limit on greenhouse gas (GHG) emissions of between 10 percent and 25 percent below 1990 levels for 2020 — on the way toward an 80 percent reduction in emissions by 2050 — along with a plan to achieve the 2020 target. Secretary Bowles has set that 2020 limit at 25 percent — and this Clean Energy and Climate Plan for 2020 contains the measures necessary to meet the limit.

Fulfilling that mandate will do much more than meet the requirements of the Act. It will allow the Commonwealth to address a number of challenges, only one of which is climate change. Most importantly, it will give powerful impetus to the clean energy revolution that has already begun.

Energy Independence: Massachusetts is at the end of the energy pipeline, figuratively and literally. All of our fossil-based energy sources — oil, natural gas, and coal — are derived from other regions of the country (e.g., the Gulf Coast or Western states) and other parts of the world, many of them unstable or hostile to the United States, (e.g., countries in the Middle East and Venezuela). Thus, all spending on fossil fuel energy — whether to fuel power plants, buildings, or vehicles — flows out of state and fails to provide income to in-state businesses or employees. This exported economic value is significant, totaling almost $22 billion in 2008.[1] In 2008, an average Massachusetts household spent about $5,200 for energy costs, of which about $1,700 was for heating (space and water), $1,300 for electricity, and $2,200 for gasoline. Almost all of these expenditures leave Massachusetts.

Energy Costs and Volatility: In addition to the economic drain represented by Massachusetts dollars flowing out of the state for energy resources, energy consumers have experienced wild price swings and long term energy price increases. The figures below show both steadily increasing and volatile prices for natural gas, electricity and gasoline.

[1] Energy Price and Expenditure Estimates by Source, Selected Years, 1970-2008, Massachusetts, U.S. Energy Information Administration (EIA). /www.eia.doe.gov/states/sep_prices/total/pdf/pr_ma.pdf

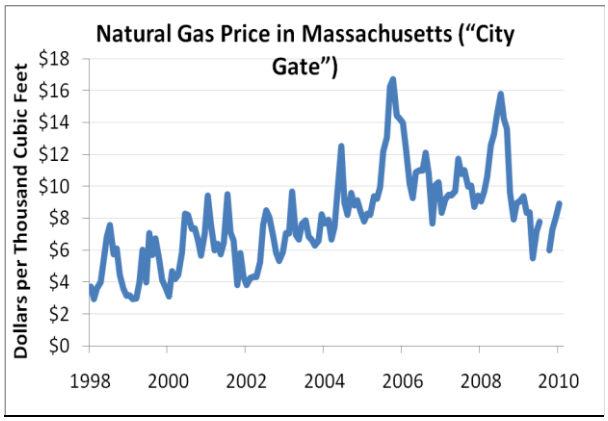


Figure ES-1. Increase and volatility in natural gas prices (source: DOER)

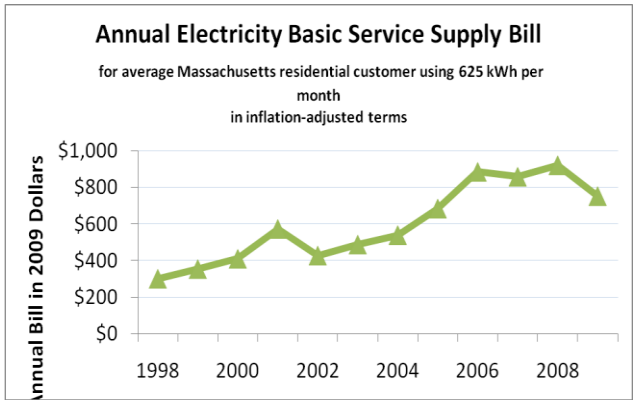


Figure ES-2. Increase and volatility in electricity prices (source: DOER)

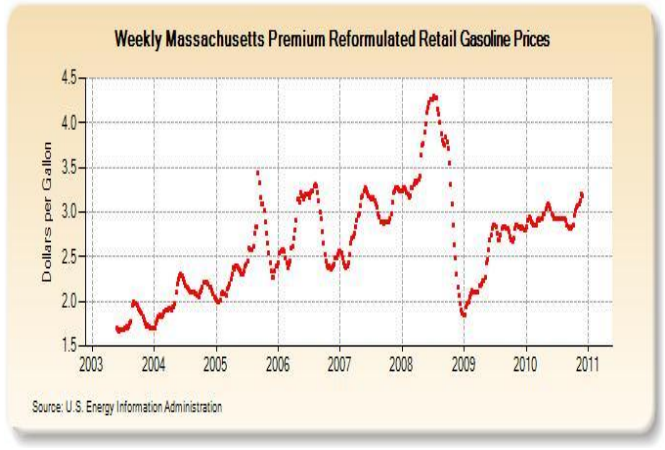


Figure ES-3. Increase and volatility in gasoline prices (source: U.S. Energy Information Administration (EIA))

Economic Opportunity: Along with the rest of the nation, Massachusetts is coming out of the most severe recession in half a century. In the transition to a clean energy economy, Massachusetts has many resources to bring to bear — and should be the disproportionate beneficiary as the economy becomes cleaner and greener. Clean Edge, Inc., has found that Massachusetts is the leading state on the East Coast for clean energy innovation, investment, deployment, and jobs.[2]

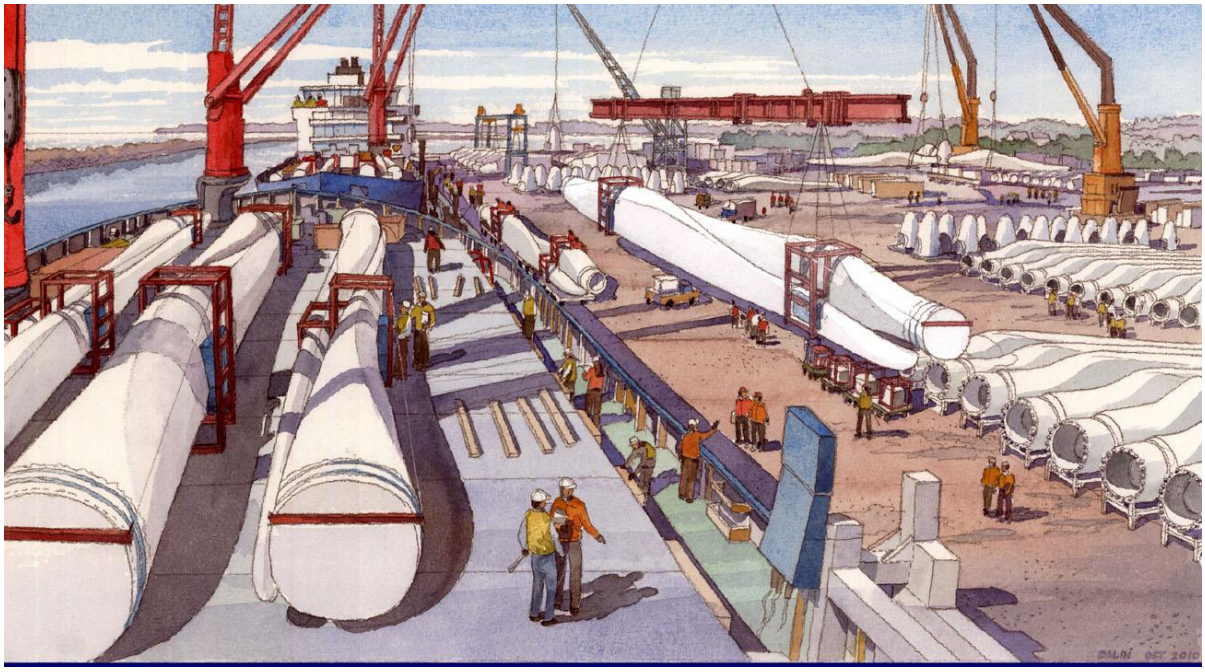
Massachusetts already has a core of companies and jobs in clean energy, and this industry has been growing even during challenging economic times. According to a Massachusetts Clean Energy Center (MassCEC) survey of 471 local companies, more than 11,000 people are employed in clean energy at the end of 2010, up 65 percent since 2007. Some 3,500 people are employed in manufacturing of energy efficiency products, with growth of 20 percent since 2007, and the fastest growth (67 percent) in energy storage, represented by such companies as A123 Systems, Inc., Beacon Power Corp., and Premium Power Corp.

Policies in this Plan will result in large reductions in fossil fuel use in buildings, electricity generation, and transportation. These include energy efficiency programs, advanced building codes, requirements for increased renewable electricity generation, federal vehicle efficiency standards, state incentives for purchasing more efficient vehicles, incentives to reduce vehicle miles traveled, and "smart growth" policies. Through both direct and indirect impacts, these policies will create an estimated 42,000 to 48,000 jobs in Massachusetts in 2020.

[2] A Future of Innovation and Growth: Advancing Massachusetts' Clean Energy Leadership, Clean Edge, April 2010, Massachusetts Clean Energy Center.

Table ES-1. Approximate Massachusetts job increases, direct and indirect, in 2020 due to Implementation of the *Massachusetts Clean Energy and Climate Plan*	
Federal and California vehicle efficiency and GHG standards	6,000
Federal emissions and fuel efficiency standards for medium and heavy duty vehicles	1,000
Pay As You Drive auto insurance (PAYD)	3,000
Clean car consumer incentives	2,000
Smart growth policy package	1,000
subtotal — transportation	13,000
Electric efficiency programs	10,000
Natural gas, heating oil efficiency programs	9,000
Advanced building energy codes	3,000
Federal appliance & product standards	1,000
subtotal — buildings efficiency	23,000
Renewables (solar, wind, biomass, biofuels)	6,000 - 12,000[3]
Total	42,000 - 48,000

Note: see the methodological appendix for sources and description of how the employment gains were estimated.



Artist's rendering of proposed New Bedford Marine Commerce Terminal, staging area for offshore wind installation. (Courtesy of MassCEC)

[3] The figure for renewables is given as a range, because most of the value added for renewables is in manufacturing, and the degree to which renewable components will be manufactured in the Commonwealth is fluid at this time, as is the degree to which the state's 2020 renewable energy requirements will be met from in-state sources.

Climate Change: The international consensus on climate released in 2007 by the Intergovernmental Panel on Climate Change (IPCC) found that the "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."[4]

Massachusetts is vulnerable to severe impacts from climate change. Impacts are expected to include increased coastal flooding from intense storms and permanent inundation of low-lying coastal areas; infrastructure and development located along the coast affected by storm surges, sea level rise, and saltwater intrusion; degraded water quality and quantity, habitat loss, and increased sedimentation and pollution of waterways due to changes in precipitation; increased number of extreme heat days, impacting those with respiratory and cardiovascular conditions; habitat for commercially important fish and shellfish species, such as cod and lobster, shifted northward; and for recreation areas, decreased average ski and snowboard seasons and increased need for artificial snow making.

Local and Regional Air Pollution: In addition to causing climate change, emissions from the combustion of fossil fuels result in a range of negative human health and ecosystem impacts. The U.S. Environmental Protection Agency (EPA) has established health-based National Ambient Air Quality Standards (NAAQS) for six pervasive pollutants that have well-documented health and environmental impacts: ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM), lead, and carbon monoxide (CO). Exposure to each of these pollutants has been linked to adverse health effects. Ozone can also irritate the respiratory system, causing coughing, throat irritation, chest pain and reduced lung function. Ozone can also aggravate asthma, leading to more asthma attacks and increased hospital admissions and emergency room visits for respiratory problems. Fine PM is associated with aggravation of respiratory and cardiovascular disease resulting in increased hospital admissions, emergency room visits and premature mortality.

These pollutants also damage ecosystems. Acid rain is created when SO_2 and NOx emissions mix with water in the atmosphere. Acid rain lowers the pH levels of lakes, rivers, and soils, harming fish and invertebrates. Exposure to ozone is associated with a range of adverse impacts to vegetation, including impairment of tree growth and loss of agricultural crop yield. Ozone can increase the rate of water loss by trees causing forests to drain streams and soils of water, thus stressing natural ecosystems beyond the trees themselves.

***Meeting Challenges, Seizing Opportunities*:** At roughly 2 percent of the U.S. economy and 1.3 percent of the nation's GHG emissions, Massachusetts could not, on its own, stop global climate change even if it reduced statewide emissions to zero instantly. However, Massachusetts is in a position to show the way to a clean energy economy — and reap direct benefits in economic growth — through the development of smart, targeted policies that reduce emissions by promoting greater energy efficiency, developing renewable energy, and encouraging other alternatives to the combustion of fossil fuels. In the process, Massachusetts will also start to get off the fossil fuel rollercoaster, become more energy independent, and jump start its economy with new technologies, new companies, and new jobs.

[4] *4th Assessment Report*, Intergovernmental Panel on Climate Change, 2007.

The *Massachusetts Clean Energy and Climate Plan for 2020* will put Massachusetts on a path to meeting its statutory obligation to reduce GHG emissions, and on the road to a vibrant clean energy economy.

Setting the 2020 Emissions Limit

The statewide GHG emissions limit set for 2020 was based on two years of analysis and public comment, and followed a process to determine the baseline Massachusetts 1990 emissions level and the predicted "Business as Usual" (BAU) emissions trajectory for 2020. The trend line of GHG emissions was found to be relatively stable since 1990 and projected as remaining relatively stable through 2020. Policies and programs implemented or initiated since the beginning of the Patrick-Murray Administration in 2007 — including the Green Communities Act and various state government executive actions, and federal government actions — are projected to result in GHG emissions reduction of roughly 18 percent — roughly the midpoint of the 10 percent to 25 percent range required by the GWSA.

Further analysis showed that it would be technically feasible to reduce emissions by up to 35 percent below 1990 levels by 2020 with additional policies that are cost-effective. In a series of eight public hearings held in June 2010, as required by the Act, nearly 200 individuals and organizations provided oral or written comment on the 2020 emissions reduction requirement and on policy measures to meet the requirement. The vast majority of commenters called for the Secretary to set the GHG limit at 25 percent below 1990 levels, the maximum allowed under the statute. The Secretary of EEA then directed state technical teams to conduct in-depth analyses of measures that satisfy criteria of cost-effectiveness and reducing GHG emissions.

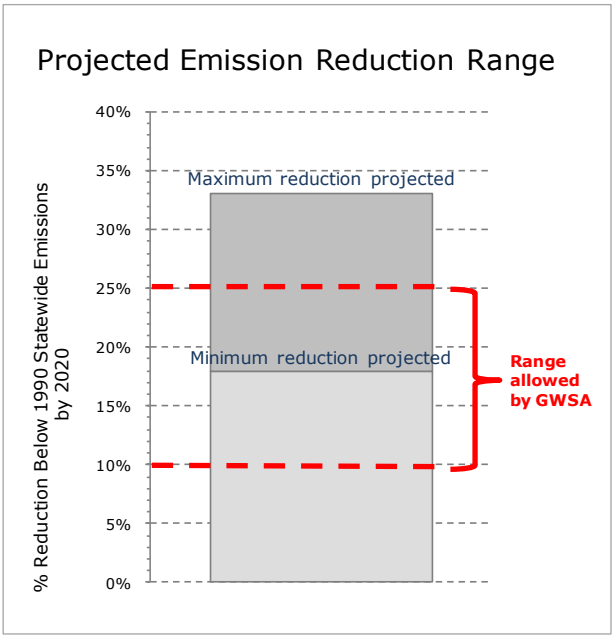


Figure ES-4. Projected emission reduction range below 1990 by 2020. The range results from uncertainties in Business as Usual (BAU) emissions, policy designs, and impacts of individual policies.

Table ES-2 (on page ES-6) displays the portfolio of policies incorporated in this *Clean Energy and Climate Plan for 2020*, and the associated potential contribution to GHG reduction below 1990 levels by 2020 for each policy. In aggregate, these policies, which include measures put in place since 2007 and new initiatives proposed in this Plan, are projected to achieve emissions reductions in the range of 18 percent to 33 percent by 2020 (see Figure ES-4). The lower end of this range represents a scenario in which Business as Usual (BAU) emissions are higher than projected and actual emissions reduction from the policies as implemented is at the low end of estimates. The higher end of the range represents a scenario in which BAU emissions are lower than projected and implementation success is relatively high. A mid-range estimate for the portfolio of policies results in GHG emissions approximately 27 percent below 1990 levels by 2020 (See Figure ES-5 on page ES-7).

Table ES-2. The Portfolio of Policies	**middle estimate % reduction below 1990**
Buildings	**9.8%**
All cost-effective energy efficiency/RGGI	7.1%
Advanced building energy codes	1.6%
Building energy rating and labeling	---
"Deep" energy efficiency improvements for buildings	0.2%
Expanding energy efficiency programs to C/I heating oil	0.1%
Developing a mature market for solar thermal water/space heating	0.1%
Tree retention and planting to reduce heating and cooling loads	0.1%
Federal appliance and product standards	0.6%
Electricity	**7.7%**
Expanded Renewable Portfolio Standard (RPS)	1.2%
More stringent EPA power plant rules	1.2%
Clean energy imports	5.4%
Clean energy performance standard (CPS)	---
Transportation	**7.6%**
Federal and California vehicle efficiency and GHG standards	2.6%
Federal emissions and fuel efficiency standards for medium and heavy duty vehicles	0.3%
Federal renewable fuel standard and regional low carbon fuel standard	1.6%
Clean car consumer incentives	0.5%
Pay As You Drive (PAYD) auto insurance (pilot program, possible expansion later)	1.1%
Sustainable Development Principles	0.1%
GreenDOT	1.2%
Smart growth policy package	0.4%
Non-Energy Emissions	**2.0%**
Reducing GHG emissions from motor vehicle air conditioning	0.3%
Stationary equipment refrigerant management	1.3%
Reducing SF_6 emissions from gas-insulated switchgear	0.2%
Reducing GHG emissions from plastics	0.3%
Cross-cutting Policies	---
MEPA GHG policy and protocol	---
Leading by Example	---
Green Communities Division	---
Consideration of GHG emissions in State permitting, licensing and administrative approvals	---
Overall reductions versus 1990 (adjusted for uncertainty in Business as Usual (BAU) emissions, policy designs, and impacts of individual policies)	
High BAU emissions and low policy impacts	**18%**
Middle BAU emissions and policy impacts	**27%**
Low BAU emissions and high policy impacts	**33%**

Note: the overall reduction is adjusted for overlap among policies, so is smaller than the sum of the individual policies. Individual lines may not sum to subtotals due to rounding.

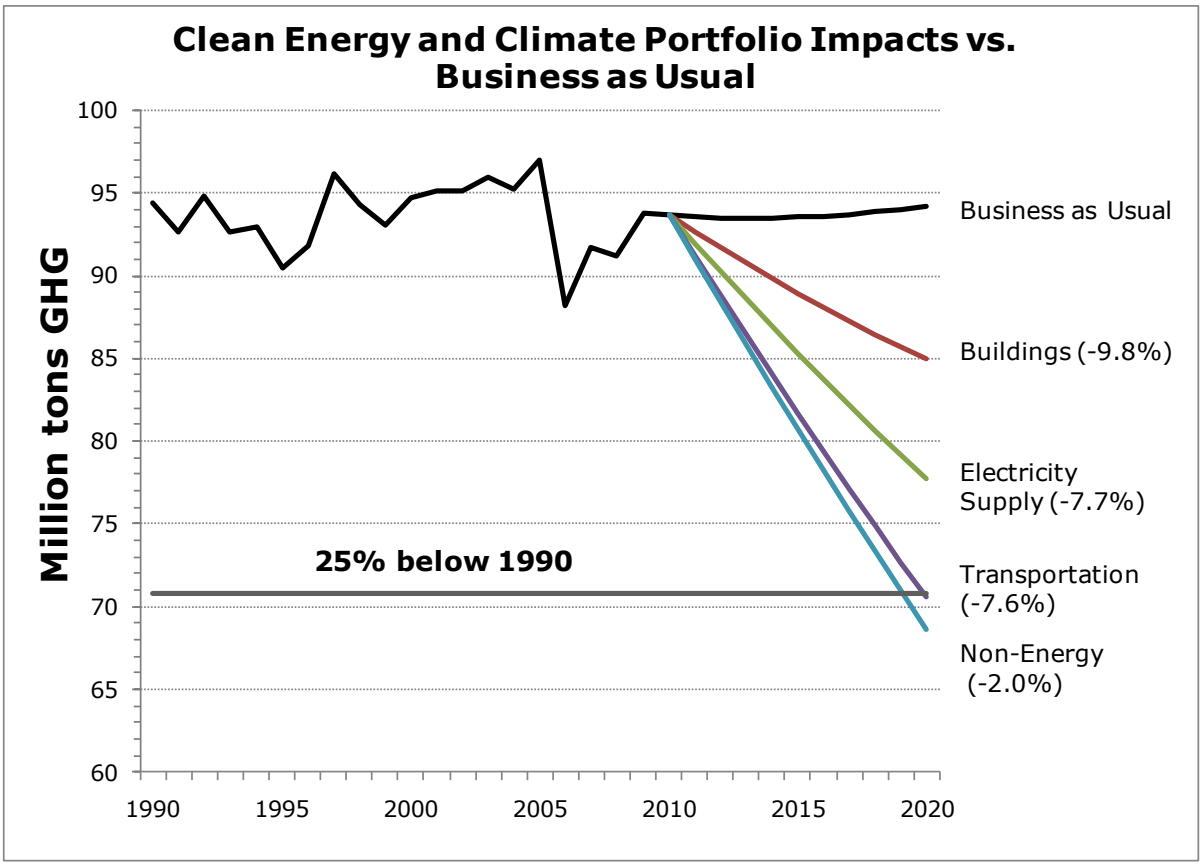


Figure ES–5. Emissions reductions by sector for the portfolio of policies, at the mid-range estimate of 27 percent below 1990 levels by 2020.

Based on these analyses, input from the Climate Protection and Green Economy Advisory Committee created by the GWSA, and full consideration of the public comments received, EEA determined that a responsible and achievable GHG emissions reduction limit for 2020 that maximizes opportunities to realize energy cost savings, increase energy independence, and promote growth in clean energy jobs in Massachusetts is 25 percent. The limit is at the high end of the range for 2020 authorized by GWSA, but the middle of the range of possible outcomes for the policies incorporated in this Plan.

An Integrated Portfolio of Policies

The GWSA provides broad authority to choose policy tools — from targeted and technology-specific policies to economy-wide and market-based mechanisms — to advance a clean energy economy while reducing GHG emissions. An integrated portfolio approach plays to Massachusetts strengths and, taken as a whole, has the greatest likelihood of reaching the goals of addressing energy costs, energy security and independence, and reducing GHG emissions.

In the last four years, Massachusetts has demonstrated the effectiveness of a portfolio approach. A combination of legislation, executive action and private sector entrepreneurship has aligned incentives and created opportunities for clean energy growth and GHG reductions.

The directive from the Secretary was to build on this portfolio — expanding existing programs where practical and developing

new complementary policies that could accelerate clean energy growth and lower GHG emissions. Each of the policies presented in this Plan — GHG reductions; cost-effectiveness; lowering energy costs for consumers and businesses; job growth; equity; implementability; and co-benefits — underwent rigorous analysis focusing on criteria established by the Act and input from the public hearings and Advisory Committee. Some policies can be put in place immediate-ly; others will be tested first through pilot programs. Not every one of these policies must be implemented to its fullest extent in order to achieve the 2020 mandate. But these represent the suite of policies that the Patrick-Murray Administra-tion is committed to pursuing over the next four years as we build on the foundation created in the past four years and work toward the 2020 emissions limit set by the Secretary.

This portfolio is divided into five categories: buildings, electricity supply, transportation, non-energy emissions, and cross-cutting policies.

BUILDINGS

9.8 PERCENT REDUCTION OF GHG EMISSIONS

Buildings consume over 50 percent of the energy used in Massachusetts and are therefore responsible for the greatest GHG emissions of any sector. Energy use in buildings comes from these two primary areas: 1) fuels for heating — primarily natural gas and heating oil, and 2) electricity for air conditioning, lighting, ventilation, appliances and equipment. The *Clean Energy and Climate Plan for 2020* takes into account Massachusetts nation-leading energy efficiency efforts mandated by the Green Communities Act (GCA) of 2008, which will produce substantial GHG reductions for 2020, and proposes additional measures that will contribute toward meeting the 2020 limit. This category is expected to yield GHG reductions of 9.8 percent.

- **All Cost-Effective Energy Efficiency**
  Existing Policy
  With the Governor's signing of the GCA of 2008, Massachusetts embarked on a path to greatly increase investments in—and return on investments from—building energy improvements. From 2010 to 2012—the first three year plan approved by the Department of Public Utilities (DPU) under the GCA mandate to capture all cost-effective energy efficiency opportunities — the state will invest over $2 billion, with an anticipated return of over $6 billion in savings for customers, and creation of thousands of clean energy jobs that cannot be outsourced overseas.

- **Advanced Building Energy Codes**
  Expanded Policy
  Massachusetts has adopted a pathway to greater energy efficiency in building codes through a commitment in the GCA to adopt the latest IECC, as well as by creating a local-option "stretch" code that has been adopted by over 60 municipalities. This policy would complete the transition to performance-based codes by 2020 that go beyond the IECC code in terms of efficiency while reducing their complexity, giving developers flex-ibility and clear performance targets and creating "green" jobs.

- **Building Energy Rating and Labeling**
  New Policy
  The real estate market currently operates without explicit consideration of energy efficiency. This policy would address this market failure by introducing an energy rating program designed to facilitate "apples-to-apples" comparisons between buildings. Initially in a pilot form, this would be the buildings equivalent of the EPA miles-per-gallon (MPG) rating on cars and light trucks.

- **"Deep" Energy Efficiency Improvements for Buildings** New Policy
  To reach our 2050 GHG reduction requirement, energy use in existing buildings must fall dramatically. To accomplish this, it is necessary to begin retrofitting buildings with much higher levels of insulation, less air leakage, and better windows than are typically installed in the retrofit energy efficiency programs. This policy, begun with pilots with utilities, would make rebates and appropriate training and technical support widely available for "deeper" energy improvements for residential buildings.

- **Expanding Efficiency Programs to Commercial/Industrial Heating Oil** New Policy
  Currently, electric utility programs provide funding for heating-related efficiency measures in homes that use oil heat but not for commercial and industrial buildings that use fuel oil for heating. Expanding the programs to such customers would yield significant cuts in energy use and GHG emissions.

- **Developing a Market for Solar Thermal Water and Space Heating** New Policy
  A policy framework will be established to develop a mature and self-sustaining market for solar thermal water and space heating in both residential and commercial buildings as part of a broader effort to support renewable heating technologies (such as clean biomass heating and efficient heat pumps) for low-grade heating needs and spur job and business growth in renewable thermal.

- **Tree Retention and Planting to Reduce Heating and Cooling Loads** New Policy
  Trees help to reduce heating and cooling loads in buildings. This policy would provide incentives to plant new trees around existing housing, and retain trees within new housing developments. This pilot program might be feasible within current utility efficiency programs, or might require new funding and/or regulatory authority.

- **Federal Appliance and Product Standards** Existing Policy
  The federal government sets energy efficiency standards for appliances, electronics, and other products. Under President Obama, the DOE has planned an accelerated schedule for setting new standards between 2009 and 2013. Nationwide these are expected to yield major savings in electricity (11.5 percent of total consumption in 2020), fuel, costs to homeowners and businesses, and carbon dioxide emissions, with Massachusetts getting its proportional share.

ELECTRICITY SUPPLY

7.7 PERCENT REDUCTION OF GHG EMISSIONS

The vast majority of existing power plants burn fossil fuels to generate electricity, producing millions of tons of pollution. Non-fossil fuel electricity generation technologies include nuclear, hydro, wind, solar, and eligible biomass and anaerobic digestion, which vary in their emissions profiles. The character of the electric power sector as a whole is determined by three key factors: the demand for electricity overall, existing generation capacity by technology type, and how much of each type of existing capacity is utilized to meet demand. The *Clean Energy and Climate Plan for 2020* relies on progress in each of these areas made since 2007, along with proposed new measures to move toward a cleaner electricity supply.

- **Massachusetts Renewable Portfolio Standard (RPS)** Existing Policy
  The RPS was created as part of electricity restructuring in Massachusetts in 1997 and then expanded in the GCA. The RPS requires retail electricity suppliers—both distribution companies and other retail suppliers—to buy a growing percentage of their electricity sales from eligible resources. The RPS will require 15 percent of electricity supply to be from renewable sources by 2020.

- **Regional Greenhouse Gas Initiative (RGGI)** Existing Policy
  Massachusetts is one of the 10 Northeast and Mid-Atlantic states participating in a regional effort to limit carbon dioxide emissions from electric generating units. The program, which began in January of 2009, establishes a region-wide cap on CO_2 emissions from fossil fuel-fired power plants that will remain at the initial level for six years then decrease 2.5 percent per year for the next four years, for a total reduction of 10 percent by 2018. Allowances are made available for purchase in quarterly auctions. Massachusetts is investing over 80 percent of its auction proceeds in energy efficiency, with smaller amounts for renewable energy and other consumer benefit programs.

- **More Stringent EPA Power Plant Rules** New Policy
  The EPA is in the midst of proposing and implementing a variety of regulations that will affect allowable water and air emissions of the nation's power plant fleet. The owners of some older, smaller power plants may find it is not economical to retrofit their plants to meet EPA's new regulations, and will instead choose to shut down the plants. In Massachusetts, The Somerset Power Station last ran in January 2010, and its permits will eventually expire if it is not restarted, and the owner of the Salem Harbor Station has indicated that it expects the plant to close within five years.

- **Clean Energy Imports** Expanded Policy
  Canada has substantial hydro-electric resources, which have very low emissions, and are available at relatively low cost and with no need for renewable energy subsidies (see RPS above). A new transmission line being developed by two Massachusetts utilities, NSTAR and Northeast Utilities Service Co., in partnership with Hydro Quebec (HQ) and with the support of the Patrick-Murray Administration would tap more of these resources. When this power line is completed, at HQ's expense, it will bring to New England enough clean power to serve up to 15 percent of Massachusetts present electricity demand. Additional transmission lines may also be possible.

- **Clean Energy Performance Standard (CPS)** New Policy
  A market-based framework is needed to provide a clear signal to the electricity market to improve upon the cleaner energy portfolios of the last few years. One approach to be considered is a CPS, which would require electricity suppliers to favor lower- and no-emissions sources in the mix of electricity delivered to their customers.

TRANSPORTATION

7.6 PERCENT GHG EMISSION REDUCTION

Transportation is second only to buildings in responsibility for GHG emissions in Massachusetts. The *Clean Energy and Climate Plan for 2020* takes into account state and federal measures to improve vehicle efficiency, reduce vehicle miles traveled (VMT), and increase use of lower-carbon fuels; and proposes additional measures that will contribute toward meeting the 2020 limit.

- **Federal and California Light Vehicle Efficiency and GHG Standards**
  Existing Policy
  The EPA and the National Highway Traffic Safety Administration (NHTSA) have set harmonized standards for light-duty MPG and GHG emissions; raising the fuel efficiency standard from 27.5 MPG at present to 35.5 MPG for model year 2016. California is expected to propose stricter standards for model year 2017-2020 vehicles, and Massachusetts law requires the Commonwealth to adopt the California standards. In combination, the federal and California standards are forecasted to yield a 17 percent reduction in GHG emissions in 2020 (primarily from lower gasoline consumption, but also some reduced emissions from vehicle air conditioning systems).

- **Federal GHG Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles** Existing Policy
  The EPA and the U.S. Department of Transportation (DOT) have announced complementary programs to reduce GHG emissions and improve fuel efficiency, for medium- and heavy-duty vehicles, such as the largest pickup trucks and vans, combination tractors (semis), and all types and sizes of work trucks and buses for model years 2014-2018.

- **Federal Renewable Fuel Standard and Regional Low Carbon Fuel Standard (LCFS)** Existing Policy
  Title II of the federal Energy Independence and Security Act of 2007 creates a "renewable fuel standard," which requires an increase in the volume of renewable fuels used in the U.S. Massachusetts biofuels law, passed in 2008, instructs the state to pursue development of a LCFS on a regional basis throughout the Northeast. The LCFS (first developed by California) would require that the average carbon intensity of vehicle fuels falls by a specific percentage compared to petroleum fuels.

- **Clean Car Consumer Incentives**
  New Policy
  There are various means by which the Commonwealth could provide incentives for consumers to shift their vehicle purchases to more fuel-efficient (or lower GHG) models. This includes varying the rates on new car sales taxes, annual auto excise (property) taxes, and registration fees, with rates raised on low-MPG vehicles and reduced on high-MPG ones. The change could be designed to be revenue-neutral to consumers as a whole and to the state. EEA and MassDOT will conduct a study to examine critical implementation challenges and possible regulatory or legislative paths for this policy.

- **Pay As You Drive (PAYD) Auto Insurance Pilot** New Policy
  PAYD would convert a large fixed annual premium into a variable cost based on miles traveled, creating a major incentive to reduce discretionary driving, while cutting the overall cost of insurance due to fewer accidents. Miles driven would fall substantially, along with CO_2 emissions and costs for gasoline, accidents, and congestion. The Commonwealth plans to conduct a PAYD pilot program initially, and, depending on results, work with the insurance industry to make this payment method more widely available.

- **Massachusetts Sustainable Development Principles**
  Existing Policy
  In 2007, the Patrick-Murray Administration updated the Massachusetts *Sustainable Development Principles*. Making state investments consistent with the *Principles* increases the amount of growth that takes place in locations and densities that reduce VMT and GHG

emissions and have other clean energy benefits.

- **GreenDOT** New Policy
  GreenDOT is MassDOT's sustainability initiative, announced through a Policy Directive by the Secretary of Transportation in June 2010. GreenDOT is focused on three related goals: reducing GHG emissions; promoting the healthy transportation modes of walking, bicycling, and public transit; and supporting smart growth development.

- **Smart Growth Policy Package** Expanded Policy
  Additional "smart growth" would make it easier for households and businesses to decrease the number and distance of vehicle trips, reducing VMT and related emissions. Massachusetts already has several policies promoting smart growth, but new, complementary policies are necessary to achieve our smart growth targets. Such policies would focus on influencing infrastructure investments by state agencies and planning decisions made by local governments.

NON-ENERGY EMISSIONS

2.0 PERCENT GHG EMISSIONS REDUCTION

Greenhouse gas emissions not related to energy use represent a small but important part of statewide GHG emissions. Although these sources currently represent only 7 percent of total emissions, many of the gases emitted by these processes have high global warming potential (GWP) — thousands of times greater than CO_2. The *Massachusetts Clean Energy and Climate Plan for 2020* addresses a number of non-energy sources of GHG emissions.

- **Reducing GHG Emissions from Motor Vehicle Air Conditioning** New Policy
  Massachusetts law requires adoption of California's emissions standards for new motor vehicles, and the California Air Resources Board (CARB) is developing regulations to reduce emissions associated with motor vehicle air conditioning (MVAC). CARB's standard aims to minimize emissions by reducing direct GHG emissions from MVAC systems, by using low GWP refrigerants and reducing leaks, as well as improvement in the efficiency of the AC system (e.g., more efficient compressors, fans and motors; systems that avoid over-chilling and reheating; and technologies to reduce heat gain in the passenger cabin).

- **Stationary Equipment Refrigerant Management** New Policy
  This policy aims to minimize emissions of high GWP refrigerants used in non-residential refrigerating equipment through: facility registration, leak detection and monitoring, leak repair, system retrofit and retirement, required service practices, recordkeeping and reporting, and eventual replacement with equipment using no-GWP or lower GWP substances, where such alternatives are available and practical. The policy would affect facilities with refrigeration units containing at least 50 pounds of refrigerant, beginning with a voluntary pilot program focused on leak detection and repair.

- **Reducing SF_6 Emissions from Gas-Insulated Switchgear** New Policy
  Through a pilot program, followed by possible regulatory action, this policy aims to minimize emissions of sulfur hexafluoride (SF_6), a high GWP substance, from leakage of gas insulated switchgear (GIS) used in electricity transmission and distribution systems by setting limits on leakage rates and implementing best management practices for the recovery and handling of SF_6.

- **Reducing GHG Emissions from Plastics** Expanded Policy
  Diverting plastics from the waste stream under this Plan will result in materials with a lower carbon content being combusted at Massachusetts' municipal waste–to-energy facilities, reducing emissions of CO_2.

CROSS-CUTTING POLICIES

Several policies pursued under the *Clean Energy and Climate Plan for 2020* do not neatly fit in the categories of buildings, electricity supply, transportation or non-energy emissions, but involve state actions that drive clean energy adoption across all of these domains.

- **MEPA GHG Policy and Protocol** Expanded Policy
  MEPA requires that all major projects proposed in the Commonwealth that have state involvement (in the form of state permits, land transfers or financial assistance, for example) undertake an assessment of project impacts and alternatives in an effort to avoid, minimize and mitigate damage to the environment to the maximum extent feasible. Building on this general requirement, the MEPA GHG Policy requires that certain projects undergoing review by the MEPA office quantify their GHG emissions and identify measures to avoid, minimize, and mitigate such emissions.

- **Leading by Example** Expanded Policy
  The Leading by Example (LBE) Program, established in April 2007 by Governor Patrick's Executive Order No. 484, works to lower costs and reduce environmental impacts at all Executive Branch agencies, public colleges and universities and quasi-public authorities. The program oversees efforts to reduce energy use by the state's buildings and vehicles, expand recycling programs, cut water consumption, promote green procurement, facilitate the construction of high performance state buildings, and reduce carbon emissions across state government. In addition, the Administration has proposed creation of a Commonwealth Energy Solutions program charged with managing and purchasing low-cost, clean energy across all public agencies, authorities, and facilities — providing an integrated strategy for energy procurement that capitalizes on economies of scale.

- **Green Communities Division** Existing Policy
  Created by the GCA, the Green Communities Division of the Department of Energy Resources (DOER) helps municipalities become more sustainable, control rising energy costs, and incubate the clean energy technologies and practices. Envisioned as a way to encourage municipalities to make greener energy decisions, the Division offer assistance to municipalities in order to be designated as "Green Communities" and qualify for grant funding.

- **Consideration of GHG Emissions in State Permitting, Licensing and Administrative Approvals** New Policy
  The Global Warming Solutions Act requires all state agencies, departments, boards, commissions and authorities to consider climate change impacts, such as GHG emissions, when they issue permits, licenses and other administrative approvals in the context of environmental review. EEA, in collaboration with other state and quasi-public agencies, will develop a plan to implement this requirement in selected agency actions.

The Road to 80 Percent Lower Emissions in 2050

The clean energy economy of 2050 will be very different than the fossil-fuel dominated economy of today. With many of the policies embodied in this Plan in place, 2050 would find a Massachusetts where energy costs are less volatile and comprise a smaller part of budgets. Businesses, households, municipalities and institutions are better able to manage their energy needs. Renewable and alternative sources of energy have largely displaced fossil-based sources, and a smart grid and advanced storage technologies release to the grid as needed electricity generated during the night by massive wind farms off the coast of the Northeast. Both small and large-scale solar installations are ubiquitous across the state. National security has been strengthened by an economy driven by homegrown sources of energy that no longer depend on fossil fuel from unstable regions or countries that do not share the interests of the U.S.

By 2050, the clean energy cluster in Massachusetts has matured, much as the biotechnology and health care sectors matured in the early part of the 21st century. Massachusetts plays a major role in the global market for technologies in offshore wind, solar PV and thermal, electricity storage and energy management. Massachusetts architects and engineers are leaders internationally in green building design and building energy management. Massachusetts companies that pioneered battery technology have robust partnerships with American, European, Indian and Chinese car and truck manufacturers.

And by law, in 2050, GHG emissions are 80 percent lower than in 1990 and the air cleaner.

Getting to this clean energy future will require significant innovation in policy, technology and business practices over the next 40 years. Unlike the 2020 limit, which can be met with actions that we take here in Massachusetts, reaching 80 percent reductions below 1990 emission levels, as required by the Global Warming Solutions Act, will mean broad changes that are beyond the reach of Massachusetts alone. Between 2010 and 2050, much will change — in the economy, in federal regulation, and in technology — that will make possible GHG emission reductions that would be unthinkable today. But in imagining — and planning for — a path to the mandated GHG emissions reduction of 80 percent in 2050, it is important to ask now: How do we get there?

The *Clean Energy and Climate Plan for 2020* describes two scenarios — one based on maximum energy conservation, the other on widespread switching from fossil fuels to electricity for transportation, buildings, and industry, powered by an extremely clean electricity supply. While there are differences between the two scenarios — the former allows marginally greater use of conventional fuels for meeting the remaining energy needs after fundamental efficiency improvements, while the latter allows for marginally greater energy utilization, as long as the source is clean — but there is more that they have in common. Both require dramatic reductions in energy use to meet heating, cooling, lighting, transportation, and production needs, and both require dramatic shifts in where the energy we use comes from.

Although it could not, by itself, get Massachusetts to the mandated 2050 emissions levels, the Plan contains a number of policies that produce modest emissions reductions for 2020 but, if put in place under the Plan for 2020, will make substantial contributions to meeting the 2050 requirement. These include advanced

building codes and building energy rating and labeling, since building stock turns over slowly. The same is true for smart growth, which will take many years to reap emissions dividends in changed transportation patterns. Also vital will be reducing the carbon content of vehicle fuels through a low carbon fuel standard, which will require the development and widespread commercialization of advanced, truly low-carbon biofuels that are not yet in the marketplace, and/or the near universal installation of fueling infrastructure for electric vehicles, which will take time.

Conclusion

Developed under the authority of the GWSA of 2008, the Commonwealth's *Clean Energy and Climate Plan for 2020* provides the means for meeting the Secretary's GHG emissions reduction requirement of 25 percent in 2020, putting the Commonwealth on track toward the GWSA's mandate of 80 percent reduction in 2050 — and accelerating the development of a clean energy economy for Massachusetts.

As this Plan is implemented, homeowners and businesses will discover new ways to save money on energy costs, make living and work spaces more comfortable, and make production processes cleaner and more efficient. The air we breathe will be cleaner, and we will be less dependent on energy from unstable parts of the world. Above all, we will be putting Massachusetts in a leadership position in the clean energy economy of the future.

Capitalizing on the state's advantages in academic resources, venture capital, and skilled resources, the measures advanced in this Plan will give rise to technological innovation and commercialization, company formation, and job creation up and down the skill ladder. There will be clean energy jobs for scientists and engineers, construction workers and insulation installers, as Massachusetts develops the products and services not only needed here, but across the country and around the world. There will be opportunities for those displaced by economic change to retool for a new industry, and for those long disadvantaged in the mainstream economy to find a new point of entry.

Clean energy is an industry of the future, but for Massachusetts, the future is now.

Deep retrofit with super-insulation. (source: DOER)

I. A Clean Energy Revolution

Between 2007 and the end of 2010, solar photovoltaic (PV) systems installed and scheduled for installation in Massachusetts increased 20-fold — with jobs in solar manufacturing, installation, and services nearly tripling — while installed wind energy increased 10-fold. In that same time period, Massachusetts launched the most aggressive energy efficiency program in the country, with estimated savings of over $6 billion for residential, municipal, industrial and commercial customers and 4,500 jobs projected. Companies that are saving on energy costs can devote those dollars to business development and job expansion. School districts that cut energy costs can devote more resources to students. Homeowners who reduce their energy bills can spend more on other needs and desires. By the end of 2010, thousands of new jobs will have been added in clean energy services, manufacturing and research and development (R&D) — this at a time when the country is undergoing the most severe economic recession in a generation. Vibrant high-tech clusters in biofuels, wind energy, solar power, energy storage, and energy efficiency services have taken root and are leading clean energy technology development globally.

This is not a vision of a *possible* future for Massachusetts. This is Massachusetts *today*.

Solar array at Chelmsford Drinking Water Plant
Photo Credit: MassDEP

Here in the Commonwealth, the transition to a clean energy economy has begun — and has already shown itself to be an engine of economic growth. Driven by an entrepreneurial private sector, and an integrated state framework of legislation, regulation and executive branch programs, Massachusetts has launched the clean energy revolution. Unparalleled academic and technical resources, local sources of investment capital, and a highly skilled workforce are all ingredients of this revolution — lowering costs to consumers, increasing our energy independence, growing clean energy jobs, and reducing our contribution to climate change and other environmental impacts. Massachusetts is poised to lead the transition to a clean energy economy nationally and to disproportionately benefit from the economic development and jobs resulting from that transition.

It is in this context that the Executive Office of Energy and Environmental Affairs offers the *Massachusetts Clean Energy and Climate Plan for 2020*. The Global Warming Solutions Act (GWSA) of 2008 requires the Secretary of Energy and Environmental Affairs to establish a statewide limit on GHG emissions of between 10 percent and 25 percent below 1990 levels for 2020, on the way toward 80 percent reduction in emissions by 2050, along with a plan to achieve the 2020 target. Secretary Bowles has set that 2020 limit at 25 percent — and the *Massachusetts Clean Energy and Climate Plan for 2020* contains the measures necessary to meet that limit. But fulfilling that mandate will do much more than meet the requirements of the Act. It will allow the Commonwealth to address a number of challenges, only one of which is climate change. Importantly, it will give powerful impetus to the clean energy revolution that has already begun. Rather

than putting a burden on our economy, a statewide mandate to reduce GHG emissions, achieved through measures that are carefully chosen, designed, and implemented to reduce costs or maximize job growth, will accelerate the transition to a clean energy economy that has already taken hold across the state.

Energy Independence

Massachusetts is at the end of the energy pipeline, figuratively and literally. *All* of our fossil-based energy sources — oil, natural gas, and coal — are derived from other regions of the country (e.g., the Gulf Coast or Western states) and other parts of the world, many of them unstable or hostile to the United States, (e.g., countries in the Middle East and Venezuela). Thus, all spending on fossil fuel energy — whether to fuel power plants, buildings, or vehicles — flows out of state and fails to provide income to in-state businesses or employees. This exported economic value is significant, totaling almost $22 billion in 2008.[5] To put this is at a smaller scale, in 2008, an average Massachusetts household spent about $5,200 for energy costs, of which about $1,700 was for heating (space and water), $1,300 for electricity, and $2,200 for gasoline. Almost all of these expenditures leave Massachusetts.

Energy Costs and Volatility

In addition to the economic drain represented by Massachusetts dollars flowing out of the state for energy resources, energy consumers have experienced wild price swings and long term energy price increases. Figures 1-3 show both steadily increasing and volatile prices for the cost of natural gas, electricity and gasoline.

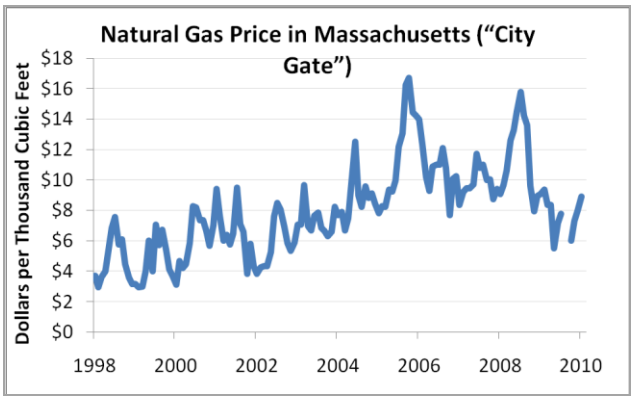


Figure 1. Increase and volatility in natural gas prices (source: DOER)

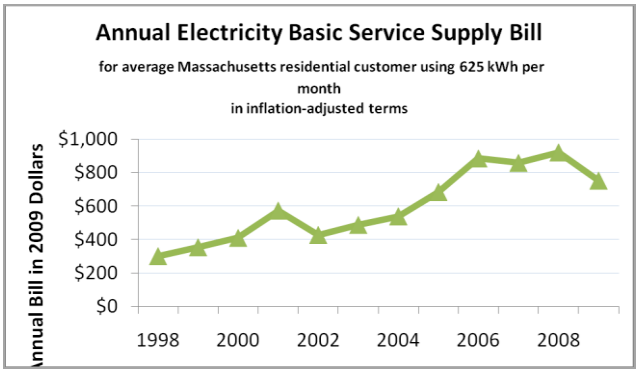


Figure 2. Increase and volatility in electricity prices (source: DOER)

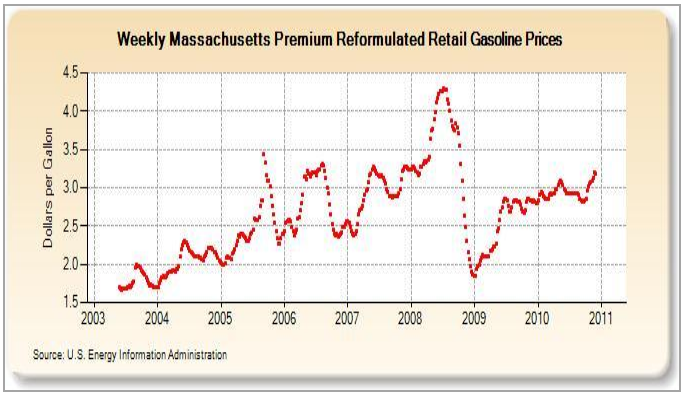


Figure 3. Increase and volatility in gasoline prices (source: U.S. Energy Information Administration (EIA))

As has been experienced numerous times in the past decades, events in other regions and countries drive global energy markets and prices, often to the detriment of Massachusetts consumers and businesses. Between 2005 and 2008, the combination of Hurricane Katrina's impact on refining and pipeline capacity and exploding demand in

[5] Energy Price and Expenditure Estimates by Source, Selected Years, 1970-2008, Massachusetts, EIA. www.eia.doe.gov/states/sep_prices/total/pdf/pr_ma.pdf

China and India for petroleum products resulted in some of the most rapid increases in energy prices that Massachusetts has experienced. Basic service electricity prices quadrupled between 1998 and 2008, before dropping at the onset of the global recession. The price of home heating oil peaked at $4.71 per gallon in 2008 and regular gasoline topped $4 a gallon. Over the past decade, price shocks have forced Massachusetts consumers, businesses and governments to struggle with an increasing burden of costs and uncertainty.

Economic Opportunity

Along with the rest of the nation, Massachusetts is coming out of the most severe recession in half a century. Massachusetts has fared better than most other states during this difficult period, but still faces a steep climb to regain the prosperity its citizens expect and deserve. Routinely recognized as one of the nation's centers of economic innovation,[6] Massachusetts has many strengths to draw on, but local fossil-based energy sources are not among them. With no oil, coal, or natural gas of its own, Massachusetts has paid dearly for energy, sending precious economic resources out of state and out of the country in order to fuel its economy. But in the transition to a clean energy economy, Massachusetts has many resources to bring to bear — and should be the disproportionate beneficiary as the economy becomes cleaner and greener.

…more than 11,000 people are employed in clean energy at the end of 2010, up 65 percent since 2007.

Jobs in solar manufacturing, installation, and services have nearly tripled in the same period, from 1,200 to 3,000

This is, in fact, already happening, as clean energy innovations developed at academic centers such as the Massachusetts Institute of Technology (MIT) and the University of Massachusetts translate into products and companies, and as laws, regulations, and incentive programs developed under Governor Patrick have created or expanded markets in Massachusetts for clean energy products and services. A study earlier this year by Clean Edge, Inc. found that Massachusetts has become the leading state on the East Coast for clean energy innovation, investment, deployment, and jobs.[7]

Massachusetts already has a core of companies and jobs in clean energy, and this industry has been growing even during challenging economic times. According to a Massachusetts Clean Energy Center (MassCEC) survey of 471 local companies, more than 11,000 people are employed in clean energy at the end of 2010, up 65 percent since 2007. Some 3,500 people are employed in manufacturing of energy efficiency products, with growth of 20 percent since 2007, and the fastest growth (67 percent) in energy storage, represented by such companies as A123 Systems, Inc., Beacon Power, and Premium Power.

Jobs in solar manufacturing, installation, and services have nearly tripled in the same period, from 1,200 to 3,000; solar manufacturing jobs alone have jumped from 750 in 2007 to 2,000 in 2010. Despite fierce competition from overseas, Marlborough-based Evergreen Solar, Inc. has more than maintained its commitment to manufacturing jobs in Massachusetts in exchange for state

[6] 2008 Index of the Massachusetts Innovation Economy, Massachusetts Technology Collaborative/John Adams Innovation Institute.

[7] *A Future of Innovation and Growth: Advancing Massachusetts' Clean Energy Leadership*, April 2010, Clean Edge, for Massachusetts Clean Energy Center.

support, with a payroll of more than 900 employees at the end of 2010. Meanwhile, 1366 Technologies, a Lexington-based start-up that received a prestigious "transformational energy technologies" grant from the U.S. Department of Energy (DOE), has developed production technology that promises to slash the cost of solar power, and plans to break ground on a Massachusetts manufacturing facility within a year.

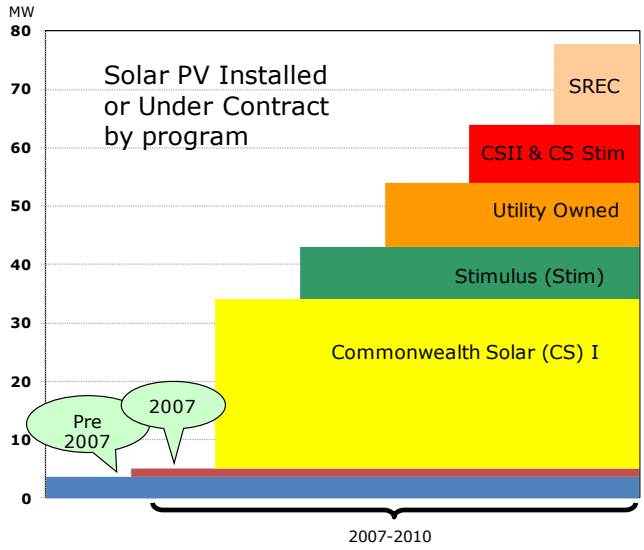


Figure 4. Expansion from 3.5 MW to over 75 MW installed and in the pipeline from 2007 to 2010. (source: DOER)

With nation-leading firms such as Conservation Services Group, Ameresco and Noresco based in Massachusetts, employment in energy efficiency services has nearly doubled, from 1,000 in 2007 to 1,972 in 2010 in just the 69 firms that responded to the MassCEC survey — representing just one fifth of energy efficiency services companies in the state. Anecdotal information indicates similar growth is taking place across the Commonwealth's energy efficiency sector.

This growth should accelerate in the coming years, thanks in part to state initiatives, including those contained in this report. From 2010 to 2012 the state's electric and gas utilities will invest close to $2 billion in energy efficiency incentives, as a result of the Green Communities Act, producing $6 billion in savings for consumers — and 4,500 direct jobs. The Advanced Biofuels Task Force estimated that development of non-food-crop-based alternatives to petroleum fuels could yield 2,500 permanent Massachusetts jobs within the industry by the year 2025, with another 3,700 jobs through indirect spending effects.[8] Massachusetts has the only tax incentive in the nation for cellulosic biofuel — exemption from the state gasoline tax, and nation-leading companies like Qteros, Inc. in partnership with research at UMass, are leading the way to a non-fossil future.

In addition to solar power, which has boomed from 3.5 megawatts (MW) at the start of 2007 to over 75 MW installed or slated for installation at the end of 2010 (see Figure 4), wind power is another local energy resource — and opportunity for economic growth. Governor Patrick has set a goal of 2,000 MW of wind — enough to power 800,000 homes — by 2020 (see Figure 5 on page 5). Much of that will come from offshore wind — the greatest renewable energy resource available to Massachusetts. At 468 MW, Cape Wind will be the first offshore wind project in the United States, and installation — which will be based in a new port facility in New Bedford — will create 600 to 1,000 jobs. Siemens AG, one of the world's largest manufacturers of wind turbines, has located its U.S. offshore wind headquarters in Boston, because of its contract to supply Cape Wind with 130 turbines, and EEW Group of Germany, a leading maker of foundations for offshore wind, has partnered with Middleboro-based Mass Tank Corp. to supply monopile foundations and other structural components

[8] "Advanced Biofuels Task Force Report," Commonwealth of Massachusetts, Spring 2008, page 20.

for Cape Wind at a new manufacturing facility in Massachusetts.

The Wind Technology Testing Center (WTTC), now under construction in Charlestown, will also bolster Massachusetts' emerging role as a center for wind energy advancement and jobs. Backed by a $25 million grant from the DOE, the WTTC will be the first facility in the United States capable of testing the large-scale (up to 90 meters long) wind turbine blades that represent the next generation of wind energy technology, specifically applicable to offshore installations. The WTTC has already attracted TPI Composites, Inc. a leading manufacturer of turbine blades, to establish an R&D facility in Fall River. Devens-based American Superconductor Corp. is engaged in development of technology for ever-larger wind turbines (a 10 MW turbine is now under development), and Massachusetts-based ePower LLC was acquired by Vestas Technology R&D Americas, Inc., one of the world's largest wind turbine companies, for its direct drive technology. With support from the MassCEC, FloDesign Wind Turbine Corporation — another "transformational energy technology" grant winner — has established a new facility in Waltham, with a promise of creating 150 new jobs as it brings its innovative "shrouded" wind turbine design to market.

In addition to companies that are providing the new technologies of the clean energy future, Massachusetts also has thousands of individuals and small companies who are taking risks and making investments to power their businesses with smaller scale energy installations to provide energy stability, diversification, and in some cases powering back to the grid. In the last four years, these entrepreneurs have invested in small-scale anaerobic digestion, solar thermal, low head hydro and geothermal.

Employment Projections for 2020

Reducing energy use through efficiency and conservation — for both buildings and vehicles — cuts living costs for households and expenses for business, improving prosperity and creating jobs. Efficiency relies more heavily on local labor and companies than do fossil-fuel based industries. Efficiency programs not only create employment directly, but households and companies will spend their energy cost savings at other businesses within the state, creating "indirect" and "induced" jobs and economic growth. Renewable energy facilities tend to be more capital-intensive, but also provide many local jobs in construction.

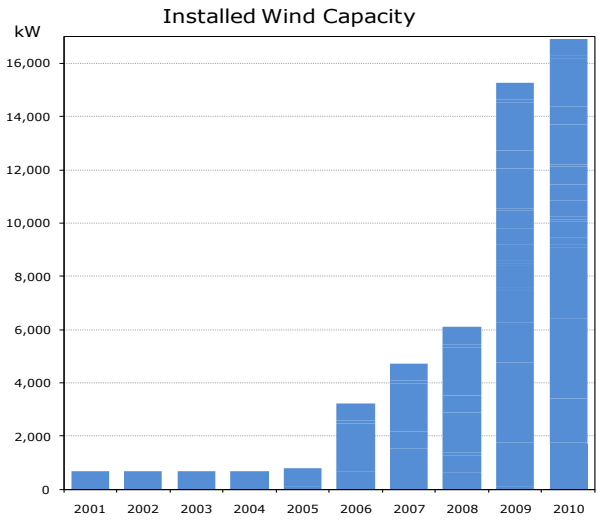


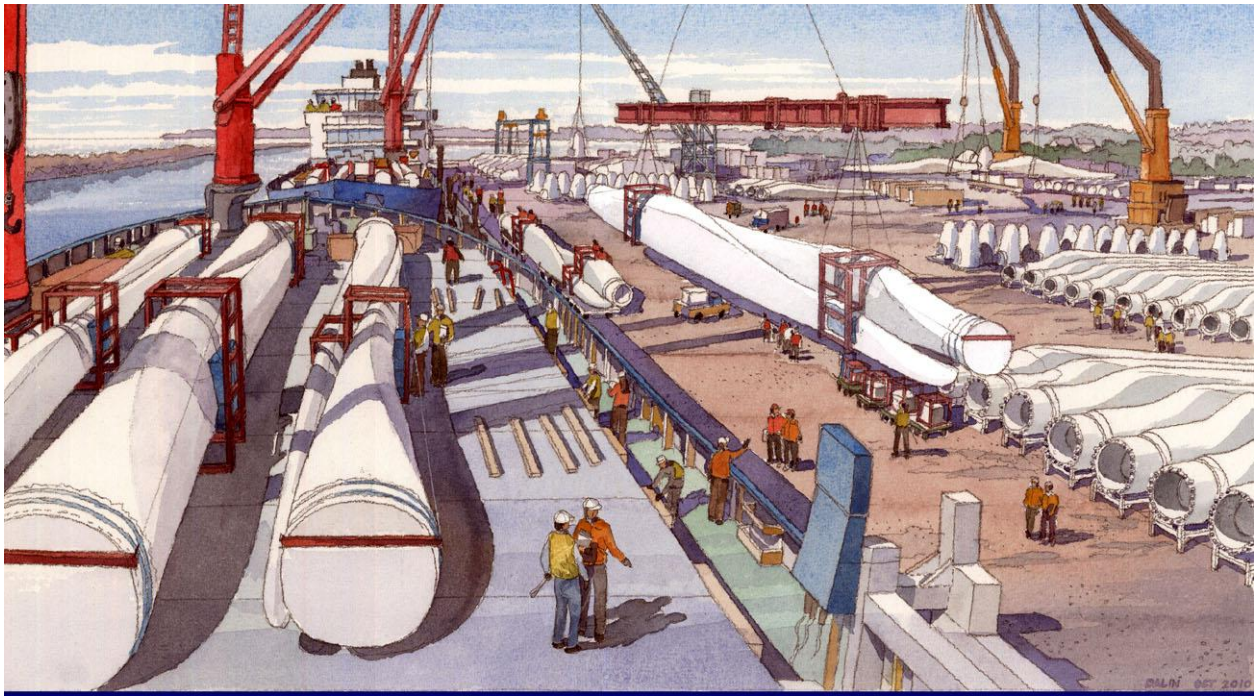
Figure 5. Expansion from about 3MW to over 16 MW installed from 2007 to 2010, with more in the pipeline. (source: DOER)

A number of the most important policies in this Plan will cause large reductions in fossil fuel use in buildings, electricity generation, and transportation. These include energy efficiency programs, building codes, requirements for increased renewable electricity generation, federal vehicle efficiency standards, state incentives for purchasing more efficient vehicles, incentives to reduce vehicle miles traveled, and "smart growth" policies. Through both direct and indirect impacts, we estimate that these policies will create 36,000 jobs in

Massachusetts in 2020, including about 13,000 via transportation policies and 23,000 via policies to improve efficiency of energy use in buildings.

The estimate for employment from in-state demand for renewable energy in Massachusetts in 2020 is 6,000 to 12,000 full-time jobs.

The figures for transportation, efficiency and renewables are based on employment needed to cover in-state demand for these clean energy sectors. They do not include the ability of Massachusetts companies to export both services and products to other states and countries in greater amounts than we import. To the degree that the Commonwealth can continue and expand its leadership in clean energy R&D, manufacturing, and service provision (such as Massachusetts companies that operate energy efficiency programs across the nation), the employment gains could be significantly larger than shown in the table on page 7. However, projecting such changes in industry growth is difficult, and beyond the scope of the modeling conducted for this Plan.



Artist's rendering of proposed New Bedford Marine Commerce Terminal, staging area for offshore wind installation. (Courtesy of MassCEC)

Table 1. Approximate Massachusetts job increases, direct and indirect, in 2020 due to implementation of the *Massachusetts Clean Energy and Climate Plan*	
Federal and California vehicle efficiency and GHG standards	6,000
Federal emissions and fuel efficiency standards for medium and heavy duty vehicles	1,000
Pay As You Drive auto insurance (PAYD)	3,000
Clean car consumer incentives	2,000
Smart growth policy package	1,000
Subtotal — Transportation	13,000
Electric efficiency programs	10,000
Natural gas, heating oil efficiency programs	9,000
Advanced building energy codes	3,000
Federal appliance & product standards	1,000
Subtotal — Buildings, Efficiency	23,000
Renewables (solar, wind, biomass, biofuels)	6,000 - 12,000[9]
Total	42,000 - 48,000
Note: See the methodological appendix for a description of how the employment gains were estimated and for the data sources and studies utilized.	

Retrofitting a house with new windows and energy efficient insulation. (source: DOER)

[9] The figure for renewables is given as a range, because most of the value-added for renewables is in manufacturing, and the degree to which renewable components will be manufactured in the Commonwealth is fluid at this time, as is the degree to which the state's 2020 renewable energy requirements will be met from in-state sources.

Transportation and buildings efficiency policies that reduce consumption of fossil fuels aid employment not only in Massachusetts, but in other states and nationally. One study, conducted at the UMass Amherst, estimated that $100 billion of national spending directed toward the green economy would create approximately 2 million jobs through both direct and indirect effects, compared to only 540,000 jobs if the same amount of money continued to be spent on oil, natural gas, and electricity. The differences are due to how much of the spending stays within the U.S. economy and to how much pays for labor expenses versus capital costs.[10]

Another recent study, "Green Jobs/Green Homes New York," estimated the economic impacts of conducting energy efficiency retrofits of one million housing units over the course of five years. It found that the program would cut home energy consumption by 30 percent to 40 percent, save New York households $1 billion annually in energy bills, and create about 120,000 "job years" (one year's worth of employment, reflecting that many of these would be temporary construction jobs). Half of these jobs would be direct results of the retrofit activity and half would come from the re-spending of increased incomes throughout the New York economy.[11]

In short, the private sector has already grasped the potential huge revenue growth by capitalizing on the Commonwealth's emerging clean energy policies and programs. The Bay State has a long and impressive entrepreneurial history, and it is that spirit — fueled by the intellect and innovation of world-class academic centers such as Harvard, MIT, and UMass, and catalyzed by the state's nation-leading clean energy policies — that will continue to propel the Commonwealth forward.

Climate Change

The international consensus on climate released in 2007 by the Intergovernmental Panel on Climate Change (IPCC) found that the "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."[12] There is broad agreement and high confidence that the documented increase in GHG concentrations is changing the earth's climate — not only raising average global temperatures but altering regional and local climatic and weather patterns. Observed effects of climate change include: increased atmospheric and ocean temperatures, heat waves, increased evaporation and changes in precipitation patterns, and a greater intensity of storms, floods, and droughts. Thermal expansion of a warmer ocean and the melting of glaciers are contributing to a rise in sea level. These trends are expected to continue for a minimum of several decades even if GHG emissions are reduced.

Global atmospheric concentrations of carbon dioxide (CO_2), methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values (see Figure 6 on page 9).

The global increases in CO_2 concentration are primarily due to increased fossil fuel use and

[10] "Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy," Robert Pollin et al, Political Economy Research Institute and Center for American Progress, Sept. 2008, page 10.

[11] "Green Jobs/Green Homes New York: Expanding home energy efficiency and creating good jobs in a clean energy economy," Center for Working Families, Green Jobs New York and Center for American Progress, May 2009, page 5.

[12] Fourth Assessment Report, Intergovernmental Panel on Climate Change, (IPCC, 2007.)

land use change, while increases in methane and nitrous oxide are primarily due to agriculture. Carbon dioxide is the most important anthropogenic (human induced) GHG. Globally, CO_2 concentrations have reached 385 parts per million (ppm) — about 105 ppm greater than during pre-industrial times. The increasing atmospheric CO_2 and other heat trapping greenhouse gases are causing an increase in the earth's air temperatures. Eleven of the 12 warmest years on record have occurred in the period between 1995 and 2006.[13] A recent study by the National Oceanic and Atmospheric Administration (NOAA) indicated that the summer of 2010 tied with 1998 as the warmest global temperature on record.

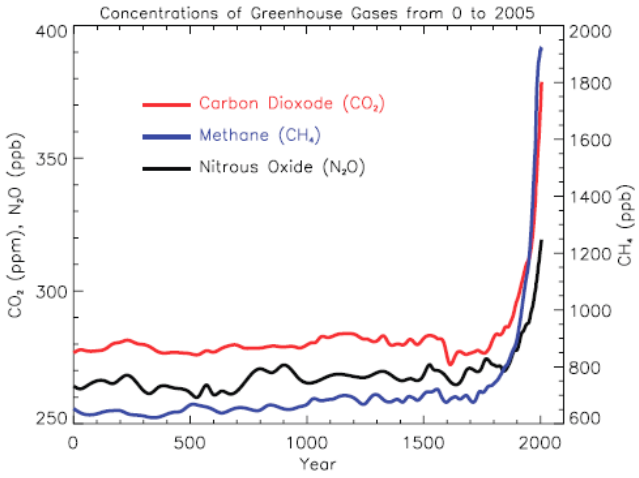


Figure 6. Increasing concentrations of atmospheric GHGs: carbon dioxide; methane and nitrous oxide. (source: IPCC)

For the period between January and September in 2010, the global combined land and ocean surface temperature was 0.65°C (1.17°F) above the 20th century average of 14.1°C (57.5°F).[14]

In order to understand the potential impacts of climate change in Massachusetts, EEA undertook a year-long study driven by the Climate Adaptation Advisory Committee, a body created by the GWSA to advise the Secretary on adaptation strategies.[15] The Adaptation Advisory Committee found that Massachusetts' climate is already changing and will continue to change over the course of this century. Under the IPCC's high emissions scenario, by the end of the century Massachusetts is set to experience a 3° to 5°C (5° to 10°F) increase in average ambient temperature[16]; summer temperatures would feel like the current summer climate of the Carolinas. Days with temperatures greater than 32°C (90°F) are predicted to increase from the five to 20 days a year that Massachusetts presently experiences to between 30 and 60 days each year (IPCC, 2007). Sea surface temperatures are predicted to increase by 4°C (8°F) (IPCC, 2007); precipitation is expected to increase in winter months by 12 percent to 30 percent, but will fall mostly in the form of rain[5]; and the number of snow days is predicted to decrease from five each month to one to three each month. Finally, while no single event can be entirely attributed to global warming, a warming climate is increasing the likelihood of more extreme weather. The Northeast has recently experienced major storms, with notable

[13] Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)], IPCC (Intergovernmental Panel on Climate Change), 2007. Cambridge University Press, Cambridge, UK, and New York, 996 pp.

[14] State of the Climate Global Analysis. National Oceanic and Atmospheric Administration, September 2010. www.ncdc.noaa.gov/sotc/?report=global

[15] Massachusetts Climate Change Adaptation Report, forthcoming.

[16] *Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast*, K. Hayhoe et al., 2006, *Climate Dynamics* 28:381-407, DOI 10.1007. www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf

rainfall and flooding events occurring in May 2006, April 2007, and March 2010.

Massachusetts is vulnerable to severe impacts from climate change. Impacts to natural resources include:

Coastal

- Substantial increases in the extent and frequency of coastal flooding and increased risk of severe storm-related damage.
- Permanent inundation of low-lying coastal areas and increased shoreline erosion and wetland loss due to projected sea-level rise and increased wave action.

Rivers and wetlands

- Alteration of stream flow timing and volumes due to precipitation changes, punctuated by increased winter flooding events and longer low-flow periods.
- Degraded water quality and quantity, habitat loss, and increased sedimentation and pollution of waterways due to precipitation changes, higher temperatures, and more frequent droughts.
- Changes in temperature will lead to shifts in wetlands species and types and/or composition, changes to wetland soils that could result in increased erosion, decreased species diversity, and reduced groundwater recharge capabilities.

Forests

- Certain species may succumb to climate stress, increased competition, and other pressures, resulting in trickle-down impacts to dependent bird and animal species, increasing vulnerability to invasives and pests.
- A shift northward of suitable habitat by 350 to 500 miles is expected for most of the Northeast region's tree species.

Climate change will also impact a number of business sectors in Massachusetts that depend on overall ecosystem health, including fisheries, agriculture, and recreation. These impacts include:

Fisheries

- As ocean temperatures continue to rise, the range of suitable habitat in the Northeast for many commercially important fish and shellfish species, such as cod and lobster, is projected to shift northward. Certain fisheries will decline in productivity, impacting the economic viability of fishing-related industries.
- Temperature, precipitation, nutrient, and salinity changes will result in a loss of habitat for marine species, altering the location or productivity of commercial and recreational fishing.

Agriculture

- Changes to growing seasons, frequency and duration of droughts, increased frequency of extreme precipitation events, and heat stress will make some areas unsuitable for growing popular varieties of produce (e.g., apples, cranberries), depress milk production from dairy cows, and increase irrigation needs to maintain viable crop production.
- A longer growing season may allow farmers to experiment with new crops, but many traditional farm operations in the region will become unsustainable without adaptation strategies that could be costly, impacting already narrow profit margins.

Recreation

- Global warming is projected to profoundly affect winter recreation and tourism in the Northeast as winter temperatures continue to rise and snow cover declines.
- With warmer winters, the average ski and snowboard season will decrease and operation costs will increase with greater requirements for artificial snow making.

Infrastructure/developed land

Climate change will also profoundly impact the built environment such as energy infrastructure, transportation, water supply, wastewater and stormwater, dam safety and flood control, solid and hazardous waste, and telecommunications.

- Key infrastructure and development that is located along the coast will particularly be affected by storm surges, sea level rise, and salt water intrusion. The 100-year coastal storm floodplain can get shifted further inland.
- Inland, the predicted changes in precipitation patterns and more frequent and intensive precipitation events will inundate development that is located in the floodplains.
- Increased temperature can affect the structural integrity of many elements of the built environment.

Human Health

Higher temperatures and intensive and increased precipitation events impact human health (especially the most vulnerable populations) both directly and indirectly.

- Higher temperatures including extreme heat days will increase heat stress, impact those with respiratory and cardiovascular conditions, increase ozone and particulate matter production resulting in poor air quality, and increase pollen production.
- Increased runoff from precipitation events can degrade surface water quality, increase outbreaks of water-borne diseases, and result in more algal blooms.

There is compelling evidence that the Northeast's climate has already begun to change, with additional changes predicted to unfold over the next century. All of these will require the implementation of adaptation measures to help decrease the state's vulnerability and increase resilience.

Impacts of Local and Regional Air Pollution

In addition to causing climate change, emissions from the combustion of fossil fuels result in a range of negative human health and ecosystem impacts.

The U.S. Environmental Protection Agency (EPA) has established health-based National Ambient Air Quality Standards (NAAQS) for six pervasive pollutants that have well-documented health and environmental impacts: ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM), lead, and carbon monoxide (CO). The federally regulated pollutant of greatest concern in Massachusetts is ozone.

Ozone concentrations in Massachusetts exceed the health-based NAAQS due to a combination of locally generated emissions (particularly from vehicles), and the transport of pollutants from states to the south and west of Massachusetts. Massachusetts' overall air quality has improved significantly over the last 25 years. Nonetheless, ozone concentrations in the Commonwealth regularly exceed the national standards, despite the adoption of a wide range of control programs that have reduced emissions of the pollutants that contribute to ozone.

Exposures to each of the criteria pollutants have been linked to adverse health effects. For example, ozone can irritate the respiratory system, causing coughing, throat irritation, chest pain and reduced lung function. Ozone also can aggravate asthma, leading to more asthma attacks and increased hospital admissions and emergency room visits for respiratory problems. Fine PM is associated with a number of serious health effects including aggravation of respiratory and cardiovascular disease reflected in increased hospital

admissions, emergency room visits and premature mortality.

In its 2010 proposed Transport Rule,[17] EPA proposes to reduce emissions from power plants in 32 eastern states. In the proposal, EPA concludes that reducing the emissions from power plants that contribute to ozone and fine PM pollution will lead to significant health benefits. EPA estimates that the national benefits, which include the value of avoiding approximately 14,000 to 36,000 premature deaths, 22,000 nonfatal heart attacks, 11,000 hospitalizations for respiratory and cardiovascular diseases, 1.8 million lost work days, 100,000 school absences, and 10 million days when adults restrict normal activities because of respiratory symptoms exacerbated by fine PM and ozone pollution, significantly outweigh the costs of the emission reductions.[18]

Since air pollution levels are highly sensitive to weather, climate change may significantly affect our overall air quality. For example, ozone is formed in warm weather, so higher summer temperatures may result in increased ozone concentrations in Massachusetts. Climate-driven increases in global and regional wild fires and dust-storms and changes in precipitation may impact PM concentrations in Massachusetts.

Criteria pollutants also damage ecosystems. Acid rain is created when SO_2 and NO_x emissions mix with water in the atmosphere. Acid rain lowers the pH levels of lakes, rivers, and soils, harming fish and invertebrates. It damages forest ecosystem health by making plant roots more likely to dry out and by washing away calcium and other minerals essential for plant growth. Exposure to ozone is associated with a range of adverse impacts to vegetation, including impairment of tree growth and loss of agricultural crop yield. Ozone can increase the rate of water loss by trees causing forests to drain streams and soils of water, thus stressing natural ecosystems beyond the trees themselves. Ozone interferes with photosynthesis, thus reducing carbon capture by trees, affecting the efficiency of large forested areas to act as carbon sinks.

Meeting Challenges, Seizing Opportunities

At roughly 2 percent of the U.S. economy and 1.3 percent of the nation's GHG emissions, Massachusetts could not, on its own, stop global climate change even if it reduced statewide emissions to zero instantly. But the severity of the climate change challenge requires leadership at every level, and Massachusetts is in a position to show the way toward a clean energy economy through the development of smart, targeted policies that reduce emissions by promoting greater energy efficiency, developing renewable energy, and encouraging other alternatives to the combustion of fossil fuels. There are opportunities to reduce emissions this way across the economy, and Massachusetts should continue to be a leader in identifying and capitalizing on those opportunities.

But, more importantly, Massachusetts can make use of the climate change imperative to get off the fossil fuel rollercoaster, become more energy independent, and jump start its economy with new technologies, new companies, and new jobs. The *Massachusetts Clean Energy and Climate Plan for 2020* will put Massachusetts on a path to meeting its statutory obligation to reduce GHG emissions, and on the road to a vibrant clean energy economy.

[17] Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone. (August 2, 2010, 75 FR 45210-45465).

[18] EPA estimates that the benefits from the reductions outweigh the costs by 60 to145 to one or 55 to 130 to one depending on the discount rate used in the economic analysis. *Regulatory Impact Analysis for the Proposed Federal Transport Rule*, EPA, June 2010, page 1. http://www.epa.gov/ttn/ecas/regdata/RIAs/proposaltrria_final.pdf

II. An Integrated Portfolio of Policies

The GWSA gives broad authority to the state to choose policy tools — from targeted technology-specific policies to economy-wide market-based policies — to advance a clean energy economy while reducing GHG emissions. Since the passage of the Act in 2008, the interagency technical team, the Climate Protection and Green Economy Advisory Committee, and an outside group of consulting experts in energy, transportation, buildings, and industrial emissions have analyzed a wide range of policies and explored other states' and other countries' efforts to make concrete steps toward a clean energy economy. Public comments collected during hearings held through the summer of 2010 focused on policy choices, design and outcomes.

In weighing the different paths forward, it became clear that an integrated portfolio approach plays best to Massachusetts' strengths and, taken as a whole, has the greatest likelihood of reaching the goals of addressing energy costs, energy security and independence, and reducing GHG emissions in the absence of broad federal action on climate and clean energy. In the last four years Massachusetts has demonstrated the effectiveness of a portfolio approach: a combination of legislation, executive actions and private sector entrepreneurship has aligned incentives and created opportunities for clean energy growth and GHG reductions. Successful energy efficiency programs, solar incentives, building codes, transportation planning, ocean planning and green jobs training are tailored to the Masaschusetts economic and workforce landscape. The portfolio that the state has built in the last four years is greater than the sum of its parts, working synergistically to launch the Commonwealth on a path to GHG reductions of 18 percent below 1990 levels by 2020.

The directive from the EEA Secretary was to build on this portfolio — expand existing programs where practical and develop new complementary policies that could accelerate clean energy growth and lower GHG emissions. Each of the policies presented in this section underwent rigorous analysis that focused on criteria established by the Act and input from the public hearings and Advisory Committee: GHG reductions, cost-effectiveness, energy cost mitigation, job growth, equity, implementability, and co-benefits.

The portfolio of policies that follow are those deemed most likely to reach our clean energy and climate goals. Some can be put in place immediately; others will be tested through pilot programs, with those that show the best results ultimately implemented statewide through regulation or legislation, as needed. Depending on actual (as opposed to projected) results, not every one of these policies must be implemented to its fullest extent in order to achieve the 2020 mandate. But these represent the suite of policies that the Patrick-Murray Administration is committed to pursuing over the next four years as we build on the foundation created in the past four years and work toward the 2020 emissions limit set by the Secretary.

This portfolio is divided into five categories: buildings, energy supply, transportation, non-energy emissions, and cross-cutting policies. Each policy is labeled as either "Existing", "Expanded" or "New". Existing policies are those that were put in place prior to our Draft Implementation Plan in June of 2010. An example is the energy efficiency programs that started with the passage of the Green Communities Act of 2008. Expanded policies are those that build on already existing policies and exand their scope. An example is Smart Growth policies. New policies are those that have not yet been initiated or were begun since June of 2010. The GreenDot policy is an example of a new policy.

Buildings

Buildings consume more than 50 percent of the energy used in Massachusetts and are therefore responsible for the greatest GHG emissions of any sector; 49 percent of GHGs, including over 21 percent from direct fuel use excluding electricity. Energy use in buildings comes from these two primary areas: 1) fuels for heating, primarily natural gas and heating oil, and 2) electricity for air conditioning, lighting, ventilation, appliances and equipment. The character of energy use in the buildings sector overall is determined by three factors: the amount and location of existing and new building space in use, the energy performance of these buildings, and the choice of energy sources. There are several effective approaches for enabling changes, primarily related to the latter two factors.[19] The issue of location is covered in the transportation chapter.

Global, national and regional studies have consistently pointed to energy efficiency and improved energy performance of residential and commercial buildings as the largest and most cost-effective clean energy opportunities. This is particularly true in the Northeast, where the combination of a cold climate and heavy reliance on heating oil results in both high heating energy use[20] and high average fuel costs. For existing buildings, energy improvements can be encouraged through financial incentives, access to financing, and rating of building energy performance. For new buildings, energy performance can be moved to higher standards through advanced building energy codes.

In addition to eliminating energy waste in buildings, there is a significant opportunity to transition to cleaner energy sources. For example, oil heating can be replaced by solar thermal, sustainable biomass/biofuels, or heat pumps, while electricity supply can be shifted from fossil fuels such as coal and oil to wind and hydro.[21]

Massachusetts began to address many of these opportunities through the Zero Net Energy Buildings Task Force, created by Governor Deval Patrick in 2008. This stakeholder group, made up of energy and building industry professionals working with the DOER, released a roadmap for the state called *Getting to Zero*[22] in March 2009.

The *Clean Energy and Climate Plan for 2020* takes into account Massachusetts' nation-leading energy efficiency efforts mandated by the Green Communities Act of 2008, which will produce substantial GHG reductions for 2020, and proposes additional measures that will contribute toward meeting the 2020 limit set as part of implementation of the GWSA.

[19] In general, the amount of building space is driven by broader trends such as economic growth, Federal policy relating to real estate and capital markets, and personal preferences. Innovations such as e-commerce, virtualization, and telepresence (telecommuting and teleconferencing) could one day substantially change the amount of building space in use.

[20] The Northeast census region uses 16% more energy per capita than the U.S. average, due largely to having 46% more heating degree days than the U.S. average. EIA Annual Energy Review 2009.

[21] Electricity supply is discussed further in a separate chapter.

[22] The "Getting to Zero" report can be downloaded at: http://www.mass.gov/Eoeea/docs/eea/press/publications/zneb_taskforce_report.pdf

All Cost-Effective Energy Efficiency

With the Governor's signing of the Green Communities Act (GCA) of 2008, Massachusetts embarked on a path to greatly increase investments in — and return on investments from — building energy improvements. From 2010 to 2012 — the first three year plan approved by the Department of Public Utilities (DPU) under the GCA mandate to capture all cost-effective energy efficiency opportunities — the state will invest more than $2 billion, with an anticipated return of over $6 billion in savings for customers.

Under the *Massachusetts Clean Energy and Climate Plan for 2020*, additional changes need to be implemented to maximize emissions reductions through energy efficiency. For example, deep energy improvements, which substantially improve building energy performance, should be encouraged in a way they are not in the existing program structure. Commercial and industrial buildings heated with fuel oil should have access to energy efficiency programs in the same way that residential buildings do. Finally, new measures, such as tree planting and retention that can reduce heating and cooling loads over the long-term, even if not so much for 2020, should be supported.

Performance-based Energy Codes

In addition to achieving energy efficency upgrades in existing structures, the Commonwealth needs to set standards for construction and rehabilitation that ensure higher energy performance. New construction in Massachusetts accounts for additions and turnover of around 0.75 percent a year in the total building stock for residential units and 1 percent for commercial space. That translates into turnover of 7 percent to 10 percent of the building stock through 2020, and 30 percent-40 percent by 2050. These buildings have an expected lifetime ranging from 30 to more than 300 years. The design of buildings newly built today and in coming years will have a large and lasting impact on fossil fuel use and corresponding GHG and local air pollution emissions.

Massachusetts has already adopted a pathway to greater energy efficiency in building codes through a commitment in the Green Communities Act of 2008 to adopt the latest International Energy Conservation Code (IECC) from the International Code Council (ICC), the body that develops and maintains model building codes for the United States. In addition to this energy code baseline, which updates every three years, the Massachusetts Board of Building Regulations and Standards (BBRS) adopted a local-option "stretch" energy code for municipalities in 2009. Over 60 municipalities in Massachusetts have already adopted this higher-efficiency code. More significantly, "stretch" is now approaching the norm: The 2009 stretch code for commercial buildings recently became the basis for the 2012 IECC code for commercial buildings, the largest improvement in the energy efficiency of the national model code in its 35 year history.

The *Massachusetts Clean Energy and Climate Plan for 2020* proposes to move away from the traditional approach of "prescriptive" codes, which set minimum standards for each building component or system, and toward "performance" or "outcome-based" codes, which set a maximum energy usage criterion for buildings but allow flexibility to meet that criterion in any number of ways. The Massachusetts stretch code has spearheaded "performance-based" energy codes, through performance targets and testing requirements for new homes and through energy modeling requirements for large commercial buildings.

By shifting to performance-driven energy codes that get progressively more effective in reducing energy needs, new construction in 2020 will use half the energy of the same buildings under a business-as-usual scenario. This results in a total savings over the coming decade of 30 percent to 40 percent of the expected energy use from new construction in residential and commercial sectors, with similar reductions in their total GHG emissions by 2020. Each year this number compounds, making it a critical component of any 2050 plan.

Energy Rating and Labeling of Buildings

In addition, this Plan proposes to use energy rating and labeling of buildings to create greater markets for energy-saving investments in existing structures. Currently, there is little data available on the energy use of existing buildings, which prevents buyers and renters — and their lenders — from placing a value on the energy performance of spaces. Under this Plan, Massachusetts proposes to pilot and then broadly deploy residential building energy labeling that allows apples-to-apples comparisons of home energy performance in much the same way that miles per gallon (MPG) ratings allow fuel efficiency comparisons of cars and light trucks. A pilot program in western Massachusetts beginning in 2011 will seek to integrate this new information on energy use into the real estate marketplace through Multiple Listing Service listings and trainings for contractors, realtors and home appraisers. In addition, Massachusetts will develop a commercial building rating pilot that would deploy both operational energy ratings (based on utility energy bills and the EPA Energy Star Portfolio Manager program) and asset ratings (similar to home energy ratings or vehicle miles-per-gallon) ratings. These two forms of ratings reveal to prospective tenants what impact on energy use previous tenants have had, as well as the inherent energy performance of the building under average tenant use. The DOER has been working with a team from both the public and private sectors to design a commercial building energy rating program, with plans to launch a pilot in eastern Massachusetts in 2011.

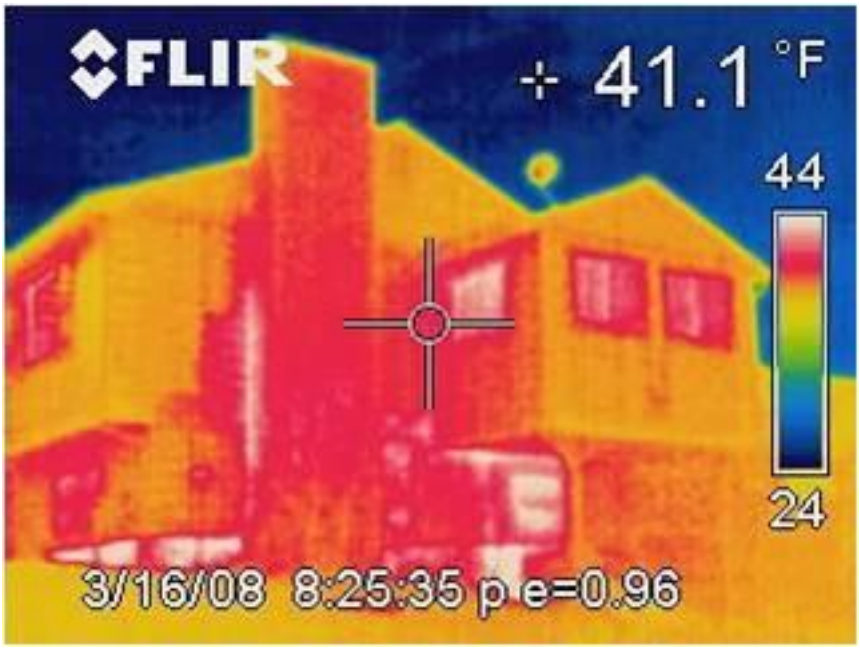
Solar Thermal Water and Space Heating

While water and space heating together account for around half of total building energy use and carbon emissions in Massachusetts, it does not require very high-grade fuels (unlike powering aircraft and motor vehicles for example). These large but low intensity heating needs make them excellent candidates for active solar heating which has no fuel expense, and can provide significant heating from a small roof, wall or ground-mounted system. Unlike in the 1970's, the technology for active solar thermal heating is now mature and comes with decade-long warrantees to protect the up-front investment in a solar thermal system. This technology has been broadly adopted and even required in new construction in places as varied as Hawaii, Cyprus, Israel, and Austria (where there is less solar radiation available per square foot than in Massachusetts). However, the market for solar thermal in New England is currently small, and needs support to reach maturity and become a broadly viable option for new and existing construction alike. Solar thermal is only one of several renewable thermal technologies that over time can replace a growing portion of our heating needs that are currently met with fossil fuels.

Buildings as Elements of Livable Communities

While improving the design and efficiency of buildings is the focus of this chapter, we cannot lose sight of the importance of location. When considering energy and GHG gas footprints of homes and businesses, siting is also a critical consideration. The chapter on transportation covers in more

depth the importance of liveable and walkable communities and the necessity of "smart growth" policies as we continue to build infrastructure in our growing economy. Consideration of these factors builds community cohesion and improves both our long-term quality of life and our economic competitiveness.



Heat leakage as shown by infrared camera, identifying where insulation and air sealing are needed. (source: DOER)

Existing Policy

ALL COST-EFFECTIVE ENERGY EFFICIENCY

Policy summary: With the Governor's signing of the Green Communities Act of 2008, Massachusetts embarked on a path toward significant energy improvements in homes and commercial buildings. The Act required that the electric and gas utilities pursue all cost-effective energy efficiency, *i.e.* eliminating energy waste whenever it is cheaper to do so than buying additional supply. From 2010 to 2012 — the duration of the first three year plan — the state will invest more than $2 billion, with an anticipated return of over $6 billion for participants. The program is administered by the investor-owned utilities in the state and the Cape Light Compact, together known as Program Administrators (PAs). The PAs work under the guidance of the Energy Efficency Advisory Council (EEAC), which represents a broad range of stakeholders.

Economy-wide GHG reductions in 2020	6.7 million metric tons; 7.1%[23]
Gigawatt (GWh) electricity savings in 2020	9,500[24]
Million BTU (MMBTU) natural gas savings in 2020	36 million
Million BTU (MMBTU) heating oil savings in 2020	7.7 million
Cumulative net benefits 2010-2020 (discounted)	$17.5 billion[25]
Jobs gained in 2020 (direct and indirect)	19,600[26]

Clean energy economy impacts: From 2010 to 2020, the program will induce investments of $10.2 billion in buildings, creating approximately 19,600 jobs in 2020. In addition, the program will generate $17.5 billion in net benefits, largely in avoided future costs of energy and avoided energy system expansion. These savings will largely enter the local economy rather than flowing out of state and out of the country, while reducing living costs for residents and operating costs for businesses.

Rationale: A substantial amount of energy efficiency is cheaper than energy supplies now provided by coal, oil, natural gas, and nuclear power. However, due to various market barriers, investments in energy efficiency fall short of optimal, either for an individual organization or for

[23] 6.7 million tons is based on expansion of the efficiency programs since 2008, due to the Green Communities Act. The program savings from levels of efficiency spending prior to 2008 are excluded, since the emissions trend in the Business as Usual (BAU) projection is estimated to include them.

[24] Energy savings in 2020 are based on the full value of efficiency programs, including the spending levels that existed prior to 2008, in order to be consistent with DOER required reporting to the Department of Public Utilities (this differs from the calculation of GHG savings, as discussed in prior footnote).

[25] $13.7 billion electric, $3.4 billion natural gas, and $0.5 billion fuel oil, all discounted to 2010 at a 2.5 percent real discount rate. Includes savings from 2010 to 2020 from the full value of efficiency programs, to be consistent with DOER required reporting to the DPU. DPU order 08-50-A directs programs to use a discount rate pegged to the 10-year Treasury note over the previous year. Rather than vary the rate year by year, 2.5 percent was used as a reasonable approximation of the real Treasury rate historically.

[26] Approximately 10,300 jobs from electric efficiency, 7,000 from gas efficiency, and 2,300 from heating oil efficiency. More than two-thirds of the employment gains are "indirect" and "induced" — due to lower energy bills causing greater respending of household and business incomes within the Massachusetts economy, and to purchases by efficiency-related companies from other businesses in the state.

the state as a whole. The PAs, as a primary point of contact with customers on energy, are well-suited to incentivize customers to undertake building energy improvements. Participation in energy efficiency could be increased greatly.

Policy design and issues: The PAs, with guidance from the EEAC and DOER, attempt to reduce consumption of electricity, natural gas, and heating oil by conducting energy assessments on buildings, and providing financial incentives for customers to implement a variety of efficiency measures, such as installing higher-efficiency lighting, HVAC systems and appliances; adding insulation to attics, walls, and basements; and reducing air leakage from buildings. Both technical and financial assistance are provided to developers of new buildings, such as the Energy Star Homes program and customized project support for commercial buildings.

There are a variety of market barriers that make achievement of all cost-effective efficiency a challenge. One of these is customers' lack of up-front capital to pay for efficiency investments, and the PAs are currently addressing this through providing subsidized financing, targeted to different types of customers. Another is the "split incentive" problem for rental space, when a tenant is paying the utility bills but only the owner has the ability to invest in efficiency measures. Efforts are also being made to address this issue.

GHG impact: The programs will reduce emissions by 6.7 million tons in 2020.

Other benefits: By reducing fossil fuel combustion, the program will help reduce criteria pollutants and other hazardous air pollutants, providing public health and environmental benefits.

Cost: From 2010 to 2020, the electricity, natural gas, and oil efficiency programs will generate $27.7 billion of energy savings, at a cost of $10.2 billion, yielding $17.5 billion in net benefits for the state, largely in avoided future costs of energy and energy system expansion.

Experience in other states: Many states have energy efficiency programs operated by utilities within a similar framework. Massachusetts' program is one of the most well established in the nation, and its 2010-12 plan represents the largest per capita investment in energy efficiency in the country.

Uncertainty: It remains uncertain how much energy efficiency there is to be captured and what program elements will capture it.

Expanded Policy

ADVANCED BUILDING ENERGY CODES

Policy summary: Massachusetts recently adopted a requirement that building energy codes meet or exceed the latest International Energy Conservation Code (IECC) and stay current with its three-year update cycle. In addition, the Commonwealth developed one of the first "stretch" energy codes, which moves away from the traditional code approach that prescribes specific energy measures that must be installed (levels of insulation, methods for air sealing, etc.), toward a "performance" oriented code that mandates a percentage reduction in total building energy use, while allowing developers to make their own design choices on how to achieve that reduction. This policy would complete the transition to performance-based codes by 2020 that go beyond the IECC codes in terms of efficiency while reducing their complexity.

Economy-wide GHG reductions by 2020	1.5 million metric tons; 1.6%
Energy saved by 2020, million BTU (MMBTU)	28 million
Net cumulative benefit 2011 to 2020 discounted (from new residential construction only[27])	$1.3 billion
Jobs created in 2020 (direct and indirect)	3,000 jobs

Clean energy economy impacts: Building construction is one of the largest economic sectors in the U.S. and is a major employer of skilled labor, with excellent potential for clean energy job growth. Between now and 2020 new construction is estimated to account for 7 percent to 10 percent of the total building stock. In addition, major renovations of existing buildings trigger code compliance requirements, and this will affect a significant percentage of buildings. The avoided fuel and electric costs due to enhanced codes will cut the long-term operational costs of this real estate and increase its durability. In addition, these projects will require more energy and design expertise, generating clean energy jobs in these sectors. In taking a leadership position on energy efficient design and construction Massachusetts-based firms are also likely to become national leaders in green design and to grow demand for their services in the increasingly global building design and engineering sector.

Rationale: Massachusetts has recently moved to the forefront of a national shift toward greater energy efficiency in building codes. This growing attention is due to the underlying economics, emphasized in analyses such as the McKinsey climate studies which point to modernized energy codes as one of the most cost-effective climate mitigation strategies.[28] Further, given the long lifespan of the building stock, decisions made today determine energy demands of the buildings sector for the rest of the century and beyond.

Massachusetts has the opportunity to build on its recent leadership in energy codes by developing a clear roadmap for both residential and commercial code reform over the next decade. Clear and bold action can ensure that we put ourselves on a path to zero-net energy buildings, and provide

[27] Cost data is not broadly available for either new commercial buildings or the residential and commercial renovation and retrofit market.

[28] The November 2007 McKinsey report: "Reducing U.S. greenhouse gas emissions: How much at what cost?" lists "improving energy efficiency in buildings and appliances" at number 1 in its 5 clusters of GHG abatement potential in the U.S. by 2030. http://www.mckinsey.com/clientservice/sustainability/costcurves.asp

improved competitiveness for our nation-leading design, construction and developer communities.

The shift from prescriptive codes that try indirectly to reduce energy waste, to performance-based codes that directly measure and reduce energy waste, is one of the clearest ways to improve energy codes. Historically it was not possible to meaningfully measure or model the energy use of residential or commercial buildings, but the advance of diagnostic tools such as duct-testing equipment, blower doors, and infra-red cameras have revolutionized that process for residential buildings. In larger commercial building spaces, the sophistication of energy models has grown rapidly.

Design issues: Building energy codes are relatively complex, particularly for commercial buildings, and there are numerous stakeholders across the design and construction supply chain to factor into the rate of improvement that is possible. The early "windfall" gains come from redirecting the emphasis of the energy code to more directly drive improvements in energy performance. Once these gains have been achieved the rate of progress will depend somewhat on design innovation and the appropriate application of new technologies that respond to marketplace demands. The dominant commercial building types are also the ones with the most turnover in real estate markets: office, retail and lab space and multi-family rental housing. The Commonwealth is looking to pilot programs in these sectors first, and to initially focus code improvement efforts there.

On the residential side the pathway to zero-net energy homes has already been paved by several industry-leading builders, who build and sell net-zero homes at both market and affordable housing prices. However, the broader market transition will take time, a focused set of building codes, and a supporting framework of training, outreach and technical assistance. More than a third of new residential construction in Massachusetts voluntarily adopted the Home Energy Rating System (HERS) index in 2009, and this has been complemented by more than 60 communities opting into the "stretch" energy code. A steady ratcheting down of the maximum allowed HERS index for new construction allows home builders and their subcontractors the time to retrain and modernize their design practices to meet performance targets without major shocks to the price of construction.

GHG impact: Estimated at 1.6 percent of statewide GHG emissions in 2020, based on an average reduction of over 50 percent in the energy use of new code-built buildings in 2020 versus 2008, and improved levels of energy code compliance.

Other benefits: A stronger emphasis on energy use requires earlier attention to building design and performance considerations than is currently practiced. This generally is the most cost-effective time to find cost savings, and results in the use of more skilled labor early in a project, while reducing energy and material costs later during construction and occupancy. Further, more energy efficient buildings can better manage air quality and moisture in a building through controlled ventilation. Energy modeling forces consideration of benefits such as daylighting that improve health, productivity and quality of life for building occupants. Added thermal insulation both reduces drafts and improves sound insulation, and mechanical ventilation reduces dust and mold build-up in homes.

Costs: On average, up-front design and construction costs are likely to increase marginally. To date, cost estimates have been in the 1 percent to 3 percent range for both residential and commercial buildings that achieve a 20 percent to 30 percent improvement over the base code. In

return for this upfront investment the developer is able to more clearly differentiate new construction as higher-performance than the stock of existing buildings, and the final owner/operator of the building receives significant energy cost savings.

Equity issues: Inability to afford heating fuel is widespread in Massachusetts, and the cost of subsidizing fuel needs of low-income households is borne broadly by ratepayers as a result. Higher-efficiency homes are a direct and sustainable method of addressing this social issue. More efficient homes reduce the cost of homeownership, they directly benefit renters who pay the cost of utilities, and indirectly benefit them when utilities are included in rents. For commercial buildings improved codes reduce the cost of doing business for retail and commercial office tenants, and operating costs fall for all investors in new commercial real estate.

Experience in other states: California is the first state to propose a roadmap to zero-net energy homes and commercial buildings, and their approach has several similarities to that proposed in Massachusetts. However, as our climates are somewhat different the specific measures and building designs differ, particularly given our heating-load dominated residential market. The commercial building sector initiatives in New York City, California, and Washington D.C. show broad support for improvement in building energy performance.

Legal authority: The building energy code is governed by the independent Board of Building Regulation and Standards (BBRS). The Department of Public Safety (DPS), EEA and DOER will continue working together to craft future energy code provisions for consideration by the BBRS. The Commonwealth could also pass legislation to clarify the scope[29] and direction of the building energy code and to provide longer-term certainty for the real estate marketplace.

Implementation issues: The residential sector has begun the market-led transition to performance-based energy codes remarkably smoothly. However, as the rest of the market follows and as energy code requirements increase, the need for training and technical assistance is likely to rise. In order to ensure and improve code compliance, ongoing resources will be needed to provide continued training in best practices to builders, designers and subcontractors working in the new construction and retrofit markets.

The commercial sector is perhaps earlier in the transition to high performance buildings, but the professionalization of design and engineering teams is higher. In order to effectively transition to performance-based codes for commercial buildings improvements and standardization in energy modeling will be needed, and there will be increased demand for building energy modelers. These are new clean energy jobs that require 21st century skill sets, and Massachusetts will only retain its leadership in green building design and engineering by cultivating this workforce.

Uncertainty: With the baseline energy codes in Massachusetts now tied to decisions of the International Code Council (ICC) there is a delegation of authority to this national body. The policy described here would reduce the uncertainty inherent in relying on the ICC by laying out a codes road map for the next three code cycles from 2012 through 2018. The impact of these codes on overall GHG emissions depends greatly on the economic performance of the broader economy and the resulting level of investment in new construction and building renovation.

[29] The mandate of the BBRS is presently limited in regard to areas such as water conservation, siting, and other "green" building considerations that impact energy use and that are addressed in recent "green" codes from ASHRAE and the ICC.

New Policy

BUILDING ENERGY RATING AND LABELING

Policy summary: The current real estate market operates without the explicit consideration of energy performance of the property – a significant factor in future operating costs. Potential building owners or tenants of either residential or commercial buildings make major investments without the ability to compare the energy performance of the buildings they are interested in. This policy would address this market barrier by introducing an energy rating program designed to facilitate "apples-to-apples" comparisons between buildings. Initially in a pilot form, this would be the buildings equivalent of the EPA MPG rating on cars and light trucks. This policy complements existing efforts to track actual energy use through utility billing data, but the ratings are intended to be independent of tenant or user behavior, and are known as "asset" ratings. The DOER is developing pilot programs for new "asset ratings" of both residential and commercial buildings.

Clean energy economy impacts: Building energy labeling is anticipated to enable significant additional investments in energy efficiency. This investment in turn leads to large reductions in fuel expenses and creates and supports clean energy jobs in residential and commercial remodeling and construction. Less spending on imported fuel will keep more money in the state economy and thereby create additional jobs.

Rationale: At present the voluntary market is providing a glimpse of the potential for an "MPG rating" for buildings. For commercial buildings the Leadership in Energy and Environmental Design (LEED) green building rating has become a must-have requirement for class-A office space in cities across the country, including the greater Boston area. But while the LEED program has steadily improved its emphasis on energy costs, it remains a poor proxy for energy savings potential, and instead signifies that the building underwent a more thoughtful design process than is typical elsewhere in the market. In addition, a growing number of relatively energy efficient buildings have opted into the Energy Star Portfolio Manager program for commercial buildings — which allows buildings above the 75th percentile in energy performance to receive an Energy Star designation.

For the residential market a similar story is apparent. The Energy Star homes program has achieved significant market penetration in MA and other states around the country, and LEED for homes is also a growing "green building" presence, alongside several other green homes certification programs.

While these voluntary programs have shown that there is market interest in energy and green design data, their impact has been limited largely to new construction, particularly toward the higher end of the market, leaving existing residential and commercial real estate markets largely unaffected. Initially developed as pilot programs serving the much larger existing buildings market, this policy could become a standardized source of energy comparison information. This would enable investment decisions that improve energy performance once developers are able to demonstrate and market the results of their investment.

Design issues: Any energy benchmarking and rating metric needs to be clear, transparent and trusted if it is to support increased energy efficiency investment. However, residential and commercial real estate markets face different design issues. For the relatively homogenous

residential market, a comparison of total annual energy needs (primarily heating and standardized electric plug loads) is likely to be the most intuitive metric. DOER, in collaboration with three other states and funding from the DOE, is launching a pilot along these lines in western Massachusetts in 2011.

For the more diverse commercial real estate market, an accurate comparison of energy needs per square foot (primarily heating, cooling, ventilation and lighting in office/retail/lab spaces) is the generally accepted metric. DOER in collaboration with a public and private sector team is developing a pilot to launch in eastern Massachusetts.

GHG impact: The GHG impact for this policy is indirect, in that it enables larger and more targeted energy efficiency investments in the covered real estate markets. It is too early to estimate the actual level of GHG savings attributable to this policy. However, given the large number of existing buildings and the equally large level of annual investment made in building renovations, retrofits and other improvements, enabling the market valuation of energy performance has the potential to foster significant private investment in energy-saving measures and hence reduced carbon emissions. Two major constraints to energy efficiency investment are lack of awareness of potential savings, and lack of credible metrics to support financing from lenders. This policy tackles both of these market failures, and enables smarter real-estate investment decisions.

Other benefits: The task of rating and labeling building energy performance is a labor intensive and skilled exercise. The resulting clean energy jobs are paid for from the energy savings and the other actionable building condition information that results from the building assessments. Energy assessments conducted for asset ratings generally uncover operational issues that can affect building durability (such as water damage, mold, and mechanical problems) as well as more energy-specific improvement opportunities. This information on buildings results in better market valuation and reduced investor risk, and also facilitates improved comfort and early identification of any health and life-safety issues.

Costs: The primary costs of energy asset rating and labeling programs is in the initial building assessments. It is critically important that these assessments are conducted in an independent, consistent and professional manner to ensure the integrity of the ratings. At the same time it is important to minimize costs to building owners and property managers. The Commonwealth is moving forward with pilot programs for both residential and commercial building energy rating to better assess the likely costs of implementation and to allow for both technology and process innovations to be tested, to reduce costs prior to any broader statewide deployment.

Equity issues: Providing access to energy use comparison data is likely to have equity benefits for low and moderate income households for whom energy costs represent a significant portion of their disposable income. As a result, there has been relatively high voluntary adoption of the Energy Star homes program by public and affordable housing programs both in Massachusetts and elsewhere in the U.S. Similarly, for the commercial buildings sector it is likely that small business owners and tenants who lease space will be the primary beneficiaries of more transparent and comprehensive access to energy comparison data in making decisions about where to lease and buy commercial space.

Experience in other states: Residential energy labeling has been successfully piloted in various metro-areas in the U.S., and has become a cornerstone of the European Union climate

and energy policy framework for buildings. Notable examples in the U.S. on the residential side include Portland, Oregon; Seattle, Washington; and Austin, Texas. On the commercial side California is moving to a mandatory utility bill disclosure and benchmarking program through Energy Star Portfolio Manager. Similar programs are underway in New York City and Washington D.C. for public sector buildings and commercial office markets. A growing number of property management companies are developing internal metrics to assess building energy assets and performance in order to inform investment decisions across their portfolio. Adopting an "asset" rating, which has credibility for building appraisers in commercial real estate, is a new idea in the U.S., although it has been the policy direction of the European Union for the past several years.

Legal authority: The Commonwealth can likely require energy ratings as part of the building code governed by the independent Board of Building Regulation and Standards (BBRS). Based on the findings of the pilots, DOER and the Department of Public Safety will develop plans for widespread adoption of rating and labeling and their possible incorporation into the building code. However, the state may opt to put such a requirement in legislation in order to provide longer-term certainty for investors and businesses in the real estate marketplace.

Implementation issues: If energy labeling pilot programs are subsequently expanded to a statewide level, the large number of existing buildings to assess and rate mean that it will necessarily take many years to fully implement this policy. As a result, the timing of market coverage will likely vary in different market segments and different geographic areas around the state. Further, in order to be effective energy ratings need to be accessible prior to any major financial transactions, and ensuring awareness and access to this information may be initially difficult while market coverage is low.

Uncertainty: The rate of adoption of energy ratings and labels by different segments of the real estate market, and the impact that this new information will have on efficiency investment decisions, is unknown. A certain threshold level or "critical mass" is needed for both the residential and commercial markets to make full use of energy comparison data in their purchasing and leasing decisions, and it will likely take a few years before a broader trend in energy efficiency investments can be seen in response to these market signals. Availability of sufficient financing to improve properties is also likely dependent on broader economic trends.

New Policy

"DEEP" ENERGY EFFICIENCY IMPROVEMENTS FOR BUILDINGS

Policy summary: To reach our 2050 GHG reduction requirement, energy use in existing buildings must fall dramatically. To accomplish this, it is necessary to begin retrofitting buildings with much higher levels of insulation, less air leakage, and better windows than are typically installed in the retrofit energy efficiency programs. This policy would make rebates and appropriate training and technical support widely available for "deeper" energy improvements for residential buildings

Economy-wide GHG emissions reduced in 2020	0.1 - 0.2 million metric tons; 0.1%-0.2%
Total Fuel Savings in 2020 (MMBtu)	2.7 million
Total Electricity Savings in 2020 (MWh)	79,000
Energy cost savings in 2020	$84 million

Note: energy savings are for the "high" case, with 0.2 million metric tons of CO_2 reductions.

Clean energy economy impacts: Deep retrofits will save large amounts of both electricity and heating fuels, reducing living costs and cutting energy imports; while expanding job opportunities for skilled contractors and construction workers.

Rationale: At present the energy efficiency program administrator (PA)-operated programs provide financial incentives for "moderate" retrofits of residential buildings, such as adding insulation to attics and walls, upgrading fossil-fuel-based heating and cooling equipment, and air sealing. If all the standard measures are done, these improvements typically achieve 20 percent to 30 percent reductions in heating energy use. While a major contributor to our 2020 emissions target, this level of savings is far from adequate for achieving the 2050 requirement of an 80 percent emissions reduction. For 2050 "deeper" measures are needed –higher and more consistent levels of insulation on all the outside surfaces of a building, along with sharp reductions in air leakage. When needed building maintenance is done without adding insulation, such as re-roofing and re-siding, there is a huge "lost opportunity" for achieving energy savings. The PAs currently have pilots that provide incentives for such deep retrofits. This policy would make such incentives a standard part of the PA offerings, with the expectation that their adoption by consumers would gradually rise from now through 2020.

Design issues: Until recently the utilities' pilot only provided incentives for whole-house deep retrofits. The cost of such retrofits is quite high, for both the homeowner and the utilities, and is unlikely to be done broadly. More attractive to homeowners may be "partial" deep retrofits, where one part of a house is done at a time when the owner was planning to do a renovation anyway. The incremental cost of energy saving improvements is greatly reduced when they are integrated with other work on the same portion of a home, such as when replacing a roof, residing exterior walls, or replacing windows. This policy would provide rebates that are substantial enough to attract widespread adoption of deep retrofits, such as rigid insulation installed below the roofing shingles or inside new siding, and triple-pane windows.

Another design option is to continue what some PA deep retrofit pilots are doing currently, paying higher incentives for comprehensive projects that go deeper still, to Net Zero Energy, Passive House and Thousand Homes Challenge levels. Once heating needs are reduced to this level, there are significant savings on heating and cooling equipment. This practice provides additional

leveraging and measure bundling advantages, and builds the skills needed to reach the 2050 GHG reduction requirement.

In addition, the particular methods that are used to evaluate programs for cost effectiveness should be reviewed to ensure that deep retrofits can be implemented to the maximum possible extent.

GHG impact: 0.1 to 0.2 million tons in 2020, depending on the rate of adoption by consumers. The state's consultants have projected a relatively small number of project completions, based on (a) homeowners only undertake deep retrofits at the time when they are doing building maintenance anyway, (b) consumer adoption begins at low levels and grows slowly until it reaches 10 percent of normal maintenance projects by 2020. Since these are long-lasting improvements to buildings the cumulative impacts continue growing beyond 2020, contributing substantially to the 2050 reduction requirement.

Other benefits: Substantial reductions in energy use, cost savings to homeowner, and improvements to building comfort.

Costs: Costs to the utility efficiency budgets and to homeowners are significant. For an expanded program that goes beyond the current pilots, impacts on utility budgets would depend on the scale of adoption by consumers.

Equity issues: In most cases the incentives for deep retrofits will be substantially larger than those offered for "moderate" retrofits. This creates possible equity issues between participants and non-participants in the program.

Experience in other states: The pilots currently underway by Massachusetts utilities are at the forefront of deep retrofit efforts in the United States. California has made a commitment to achieving sharp reductions in energy use by existing buildings, and the Province of Yukon in Canada has a program to super-insulate existing buildings.

Legal authority: These kinds of programs fall within the authority of the electric and gas utilities under their existing efficiency programs.

Implementation issues: Deep retrofits involve more complex construction techniques than are needed for conventional construction or moderate retrofits. To achieve the projected energy savings, and to not create or worsen other problems such as moisture and mold issues in a home, the deep retrofit shell must be installed correctly. As less heat is used in a building the drying potential is greatly reduced, so both interior and exterior water management details become critical for the health of occupants and durability of the structure. To avoid other indoor air quality problems, as well as to capitalize on smaller heating loads, shell measures should be carefully integrated with mechanical ventilation and smaller heating equipment that has sealed combustion or forced draft. Further, deep measures, if installed incrementally, should be deployed in a manner that does not hamper future energy improvements. This requires contractors with appropriate deep retrofit expertise, partnered with others with advanced HVAC expertise. At present these skills\teams are in limited supply and there is a need for training of contractors, along with a contractor guidance and inspection component such as in the Energy Star Homes program. Also needed is a system or incentives for a party involved to have long-term responsibility for the energy performance, durability, health, and safety of buildings that undergo deep retrofits.

Uncertainty: The rate of adoption of deep retrofits by consumers, even with substantial utility incentives, is not known and could be lower than projected. Availability of sufficient funds, from utility budgets or other sources, could be a question if the rate of adoption is high.

New Policy

EXPANDING ENERGY EFFICIENCY PROGRAMS TO COMMERCIAL/ INDUSTRIAL HEATING OIL

Policy summary: At present the electric utilities provide funding for heating-related efficiency measures in homes that use oil heat. There is no funding available for commercial and industrial buildings that use fuel oil for heating. Expanding the programs to such customers would yield significant cuts in energy use and GHG emissions.

Economy-wide GHG emissions reduced in 2020	0.1 million metric tons; 0.1%
MMBTU oil savings in 2020	230,000

Clean energy economy impacts: These programs would result in increased employment in efficiency audits and installation of efficiency measures and reduced spending on fuel oil imports, which keeps more money in the state and thereby helps to provide jobs throughout the Commonwealth's economy. Companies using fuel oil would see lower operating costs, which increase their ability to continue operating in Massachusetts.

Rationale: The exclusion of commercial and industrial (C/I) customers from oil heating efficiency programs is a significant missed opportunity for reducing energy use and GHG emissions. Given that heating oil is a relatively high-carbon fuel, and that the lack of programs in the past means that such buildings will typically have low efficiency levels, the savings both in energy and GHG should be relatively high per dollar of funds spent.

Design issues: At present there may not be legal authorization for the electric utilities to provide funding to C/I customers in the same way that they do for residential customers. If this is the case then other funding sources will be needed, such as RGGI funds.

GHG impact: Assuming that C/I customers participate at the same rate, relative to their total use of heating oil, as do residential customers at present and as projected for the future, we estimate savings of 0.1 million metric tons of CO_2 in 2020.

Other benefits: Non-CO_2 air pollutants from fuel oil will be reduced due to lower consumption, including reductions in SO_2, NO_x, and particulates.

Costs: Relatively small since C/I customers constitute only about one-quarter of total heating oil consumption in Massachusetts, with the rest being residential.

Equity issues: Heating oil customers do not pay into a specific efficiency funding pool, as do electricity and natural gas customers. However, in almost all cases they are also electricity ratepayers, and as with residential customers, if there are highly cost-effective efficiency opportunities available for heating-related measures, it can be argued that this is a good use of utility-administered efficiency funds. If other funding sources are used, equity considerations will depend on the source.

Legal authority: Needs further investigation, depending on anticipated sources of funds.

Uncertainty: Measures to improve the efficiency of building shells, heating systems, and heating distribution systems are well known and there is extensive experience with them, so there is little risk of not being able to achieve cost-effective energy and GHG savings.

New Policy

Developing a Mature Market for Solar Thermal Water and Space Heating

Policy summary: A policy framework will be established to achieve a mature and self-sustaining market for solar thermal water and space heating in both residential and commercial buildings. This support for the nascent solar thermal market is part of a broader goal of developing renewable heating technologies (such as clean biomass heating and efficient heat pumps), to facilitate a market transition to renewable fuels as the dominant fuels for heating purposes by 2050. The policy will also establish robust job and business growth in the renewable thermal sector in the Commonwealth.

Economy-wide GHG emissions reduced in 2020	0.1 million metric tons; 0.1%

Clean energy economy impacts: Large reductions in fuel costs in exchange for investments in solar thermal heating equipment will reduce the cost of living for residents and the cost of business for commercial customers. New installations will result in the growth of the solar thermal industry in Massachusetts, and to a lesser extent, local maintenance work. Directly offsetting spending on imported fuel will keep more money in the region and thereby create additional jobs in the broader state economy.

Rationale: Hot water and space heating are large energy users that do not require very high-grade fuels (unlike motor vehicles for example). This makes them excellent candidates for active solar heating, which has no fuel expense and can provide significant heating from a small roof, wall or ground-mounted system. Unlike in the 1970's, the technology for active solar thermal heating is now mature and comes with decade-long warrantees to protect the up-front investment in a solar thermal system. However, the market for solar thermal in New England is currently very small, and needs "infant industry" support to accelerate its growth to the scale needed to maintain continued growth and provide a realistic option to interested customers.

Design issues: Similar to the Solar PV industry in MA prior to its recent exponential growth in the last four years, the small size of the solar thermal market burdens it with high levels of "soft" costs in sales and marketing (finding customers and designing and installing well-sized systems). This forms a barrier to consumer awareness and competitive pricing in comparison to the dominant market share of fossil fuel-based heating systems. The "hard" costs of quality equipment are being driven down by global market growth, and so once Massachusetts can develop a significant demand entrepreneurial companies will likely be able to bring turn-key pricing down considerably. Solar thermal systems require a back-up system in the event of a cold and cloudy week in winter, so most customers will retain their pre-existing fossil fuel heating system and new construction will likely move to on-demand electric or much smaller backup fossil fueled boilers .

GHG impact: For purposes of this Plan, a modest 0.1 million ton reduction in emissions due to solar thermal is forecast. However, larger reductions could be attained through a broader program applying to all renewable thermal technologies, including heat-pumps, biomass/biofuels, and solar thermal. If the displacement of 20 percent of the fuel oil used for thermal energy and 50 percent of propane heating and electric water heating could be attained, this would reduce GHG emissions in Massachusetts by approximately 2 million tons, or slightly more than 2 percent

of total 1990 emissions. This 2020 goal would be for all renewable thermal technologies, including heat-pumps, biomass/biofuels, and solar thermal applications. GHG emissions from biomass and biofuels used for thermal energy are important to consider, but Massachusetts policies will limit the eligibility of feedstocks (advanced biofuels and residue woody biomass) to those which demonstrate real and rapid GHG benefits, such as advanced biofuels and residue woody biomass

Other benefits: Expanding solar thermal energy will create and expand businesses in Massachusetts in a manner similar to our early stimulation of the solar PV market. For solar PV, the Commonwealth has added 1,800 new jobs since 2008 when the solar PV programs were launched. PV installations grew from 3 MW to 35 MW between 2007 and 2010, with another 35 MW in the development pipeline. Jobs will include system marketing, design, finance, installation and maintenance, along with manufacturing and fabrication of solar thermal panels and system components. In addition a mature solar thermal market complements the utility energy efficiency and advanced building energy codes policies. For existing homes in particular, there is a large stock of buildings that are heated with hot water, and where solar exposure is available these distribution systems can be easily retrofitted to provide space heating from renewable solar heated water with the fossil fuel systems retained as back-up systems.

Costs: In order to accelerate the market for solar thermal systems a highly publicized state rebate program analogous to the successful Commonwealth Solar program for PV is recommended. Due to the lower per system costs of solar thermal the MassCEC has proposed launching a pilot program to explore the most effective way to implement such a program. Any state rebate would leverage existing incentives primarily from Federal tax credits and the utility managed zero-interest HEAT loan program.

Equity issues: As with any upfront capital intensive investment, the early adopters of solar thermal systems are often relatively affluent homeowners, large well capitalized businesses, and the public sector, that have the resources to take advantage of the long term benefits of renewable heating both for their bottom-line and co-benefits. However, these early actors catalyze the market, provide useful exposure and marketing, and bring down costs, all of which makes these technologies increasingly accessible and desirable to the broader market. Among the early adopters of solar PV in Massachusetts was the public housing and affordable housing sector, with a notable role played by Boston Community Capital.

Experience in other states: Solar thermal subsidies to support the industry are relatively widespread and have grown in use in U.S. states including: New Hampshire, California, Delaware, Wisconsin, New Jersey, and Arizona. Total state incentives typically account for 25 percent to 50 percent of the system installed cost, but are expected to fall substantially over time. In particular, Arizona, Nevada, North Carolina and Washington D.C. have added solar thermal to the "solar carve-out" of their Renewable Portfolio Standard (RPS) programs, which are primarily designed to support electric renewable energy sources. Massachusetts would also have this option once a pilot rebate period runs its course.

Legal authority: In order to add an incentive for solar thermal to the Massachusetts RPS regulations, new legislation would be required. In the absence of this, the Clean Energy Center is able to provide rebate funding and other incentives to thermal renewables as part of their enabling mandate in the Green Communities Act of 2008.

Implementation issues: The perceived barriers to solar thermal adoption can be summarized in the following four areas:

1. Upfront cost of system
2. Lack of consumer education and confidence
3. Shortage of experienced solar hot water designers
4. Permitting costs and inspections

All of these can be addressed in a well designed pilot, followed by a broader program.

Uncertainty: Projections of the rate of adoption of solar thermal systems in response to a well designed solar thermal incentive program are highly uncertain. The precise rate at which rebates or other incentives would be taken up by the private market is also unknown. However, the lessons of the Commonwealth Solar Rebate program for PV and the experiences of other states are instructive. As with any alternative to fossil fuels, the volatility in the price of oil and to a lesser extent the price of natural gas over the coming decade is a critical uncertainty.

New Policy

TREE RETENTION AND PLANTING TO REDUCE HEATING AND COOLING LOADS

Policy summary: Trees help to reduce heating and cooling loads in buildings. This policy would provide incentives to plant new trees around existing housing, and retain trees within new housing developments, to conserve energy and reduce GHG emissions. This pilot program might be feasible within current utility efficiency programs, or might require new funding and/or regulatory authority.

Economy-wide GHG emissions reduced in 2020	100,000 metric tons in 2020, 300,000 tons in 2035 from trees planted by 2020

Clean energy economy impacts: On the order of 500 direct jobs per year from the scale of tree planting envisioned here, in nurseries, planting, and maintenance. Reduced energy costs and lower fuel imports.

Rationale: Strategically located around housing, trees can significantly reduce cooling and heating loads.[30] Retaining trees when new homes are built, and planting new ones around existing housing, can be a low-cost means of saving energy and reducing GHG emissions. Optimally trees should be located on the southeast and southwest sides of a building to provide shade and reduce air conditioning load. Evergreen trees planted on the north and northwest sides (given prevailing winds in Massachusetts) provide wind breaks and can reduce winter heating needs. Retaining and planting trees could be subsidized by the electric and gas utilities on the same basis that they provide incentives for other efficiency measures.

Design issues: For existing residential buildings, incentives could be provided to owners to plant new trees in the correct locations. For new housing development, incentives could be provided to developers to retain existing tree cover, and to particularly keep trees in the optimal locations for cooling and heating savings. Another option would be to provide incentives to municipal governments that pass local planning ordinances requiring developers to follow specific tree retention practices. Because trees generally take 15 years to reach their full shade potential, this policy would need to begin soon to have much impact by 2020. On the other hand, even if impacts by 2020 are small, they will rise after 2020 as trees mature, contributing to the 2050 GHG requirement.

[30] Studies of large scale tree-planting programs in New York, Chicago, and Philadelphia resulted in a 1.7C average reduction in maximum air temperature in the hottest areas. Chicago heat island reduction measures reduced annual cooling degree days by 39. "Energy Savings for Heat-Island Reduction Strategies in Chicago and Houston (including updates for Baton Rouge, Sacramento, and Salt Lake City*," S.* Konopacki and H. Akbari, 2002, Lawrence Berkeley National Laboratory LBNL-49638; "Shade trees reduce building energy use and CO2 emissions from power plants," H. Akbari, 2002, *Environmental Pollution* 116: S119-S126; "Energy conservation potential of urban tree planting," E.G. McPherson and R.A. Rountree, 1993, *Journal of Arboriculture* 19(6):321-331. Trees also reduce ambient air temperature through evapotranspiration. Per-tree calculation: a single white spruce with dbh 8inches is projected to save 1.1MBTU in heating energy for a single family home in Boston. (Casey Trees, based on the USFS iTree model). Toronto area heat energy savings: single family residences saved 3 percent (built pre-1980) and 2.5 percent (after 1980); efficient R-2000 houses 2 percent; row-houses 1.6 percent (built before 1980) and 1 percent (built after 1980) (Konopacki and Akbari, 2002).

GHG impact: About 100,000 metric tons CO_2e potential by 2020 under realistic assumptions of possible participation. Savings become much greater over time, rising to 300,000 tons in 2035 from the trees planted/retained by 2020, because most will not have reached their full growth until well past 2020. (Note that GHG savings from trees sequestering CO_2 are real but are not included here. Due to data problems, tree sequestration is not included in the 1990 baseline emissions estimate, nor are reductions or increases in sequestration in the years since then included. Without those numbers it is not valid to include sequestration gains due to a policy measure.)

Other benefits: Trees significantly improve the quality of life for immediate residents and the neighborhoods around them. This may have other secondary benefits which have not been quantified — such as higher real estate values, better-maintained homes, lower crime, etc.

Costs: Depending on the scale and scope of these programs, their costs could vary greatly. More than most efficiency programs, the benefits accrue over a long time period. Pilot programs between state agencies and utilities will allow for analysis of cost and benefits, as well as identifying implementation issues. One current estimate is on the order of $150 per tree for purchase and planting.

Equity issues: To fairly distribute benefits to urban and lower-income residents, it would be essential to ensure that the tree planting take place on a large scale in cities as well as around suburban homes, despite the likelihood of greater siting difficulties. As with the existing efficiency programs, this could be a particular challenge for rental housing, where landlords often lack the incentive to cut energy costs when tenants are paying the electricity and/or heating bills. Greater efforts would need to be made to achieve participation in rental properties.

Experience in other states: Utility-funded tree-planting programs are already in place in several cities and states. Sacramento, CA has avoided the cost of constructing a new 19 MW power plant by planting over 450,000 trees next to homes. With funding from the Sacramento Municipal Utility District (SMUD), the Sacramento Shade (for residences) and Neighbor Woods (for public spaces) Programs aim to plant 5 million trees by 2025. Residents are eligible for up to 10 free trees. SMUD estimates that each tree provides $90 in annual benefit.[31] In Iowa, the Municipal Tree Planting Program is a partnership between the non-profit Trees Forever and four utilities, in which the utilities provide funding for community planting programs.[32] Here in Massachusetts, Grow Boston Greener is a collaborative effort of the City of Boston and its partners in Boston's Urban Forest Coalition to increase the urban tree canopy cover in the city by planting 100,000 trees by 2020.

---

31 The partnership between the Sacramento Municipal Utility District and Sacramento Tree Foundation has been ongoing since 1990. http://www.smud.org/en/residential/trees/Pages/index.aspx or http://www.sactree.com/doc.aspx?25 . Riverside, California program: http://www.riversideca.gov/UTILITIES/resi-treepower.asp. Pasadena, Alameda, and a number of other California utility companies have similar programs. Initiatives to capture environmental savings from trees are also underway in more temperate climates. The Department of Public Services in Portland, Maine will deliver and plant trees that residents purchase at local nurseries. The "Treebate" program in Portland, Oregon offers residents a rebate on trees they purchase and plant (funded for water quality). Washington, DC residents can receive a $50 rebate for each eligible species of tree.

32 www.treesforever.org

Legal authority: PAs have the authority to conduct pilots and to expand these into new efficiency programs, based on approval of the Energy Efficiency Advisory Council and the DPU. Pilots will help determine whether and over what time period energy savings exceed costs. The results of such pilot programs will help determine the value and feasibility of tree planting and retention activities.

Implementation issues: This would be a pioneering program in the northeast, and so a variety of program approaches to achieving participation, planting trees effectively, and maintaining them could occur.

Uncertainty: We do not know the degree to which residents will be willing to participate, even with subsidies; nor the degree to which developers and landlords will participate; nor municipalities for a program design in which they require developers to retain trees.

Existing Policy

FEDERAL APPLIANCE AND PRODUCT STANDARDS

Policy summary: The federal government sets energy efficiency standards for appliances, electronics, and other products. Under President Obama, DOE has planned an accelerated schedule for setting new standards between 2009 and 2013. Nationwide these are expected to yield major savings in electricity (11.5 percent of total consumption in 2020), fuel, costs to homeowners and businesses, and carbon dioxide emissions, with Massachusetts getting its proportional share.[33]

Savings (above current trends)[34]

Economy-wide GHG emissions reduced 2020	0.5 million metric tons; 0.6%
Electricity saved — Gigawatt hours (GWh) 2020	1,040[35]
Natural gas, fuel oil saved — MMBtu	2.9 million
$ value energy savings in 2020	$330 million
Cumulative net benefits 2011-2020 (discounted)	$2.7 billion
Jobs gained 2020 (direct and indirect)	1,200 jobs

Clean energy economy impacts: Reduction of $330 million in costs in 2020 will improve cost of living for residents and reduce operating costs for businesses, also helping to keep jobs in the state.

Rationale: As with most efficiency measures, appliance and product efficiency faces market barriers that result in consumers making short-term purchasing decisions that don't reflect the optimal financial decisions long-term. To some degree this occurs because products, particularly appliances, are often bought on an emergency basis when the old item has failed. By mandating that products be built to specifications that will minimize their lifecycle costs, including both capital and energy costs, DOE can drive large savings.

Policy design and issues: The federal government sets nationwide standards, in some cases, due because climate conditions standards vary by region (such as with windows), but in other cases DOE has not made this distinction, as with heating system efficiencies. For this reason, Massachusetts applied for a federal waiver to set a standard for gas furnaces higher than the 80 percent federal standard, due to our colder climate. DOE denied Massachusetts' waiver request; although it has said that it is looking to develop a higher standard for the entire northern tier of the country.

[33] "Ka-BOOM! The Power of Appliance Standards. Opportunities for New Federal Appliance and Equipment Standards," American Council for an Energy-Efficient Economy and Appliance Standards Awareness Project, July 2009.

[34] Because federal standards have existed in the past and exist today, the state's consultants estimate that half the savings from forthcoming standards are already embedded in the "business as usual" trend lines; so only half the savings expected from the planned federal standards are included here. Also, the savings given here for 2020 include a portion of savings over the lifetime of products purchased by 2020, some of which occur after 2020.

[35] "State-Level Benefits from Potential Federal Appliance Standards," Appliance Standards Awareness Project, 2009.

GHG impact: ACEEE and the Appliance Standards Awareness Project (ASAP) forecast that the forthcoming standards will reduce GHG emissions by 1.0 million tons in 2020. The Commonwealth's consultants estimate that half of these reductions are already counted in the business-as-usual (BAU) trend for electricity emissions in 2020, and so 0.5 million tons are counted as a reduction versus the BAU.

Other benefits: The standards yield large savings in electricity and costs. In parallel with the GHG reductions, half of the savings are counted in the existing trends, so the incremental gains are estimated at 1,040 gigawatt hours of electricity and $200 million in 2020.

Costs: Incremental costs of production vary for each product, and are required to be less than the lifetime energy savings in each case in order for DOE to set a standard. Sample costs are $52 for a refrigerator, $50 for a clothes dryer, and $2 for microwave ovens. There have been reports of more frequent or more expensive repairs needed for some items, such as the computer boards for variable speed motors in refrigerators.

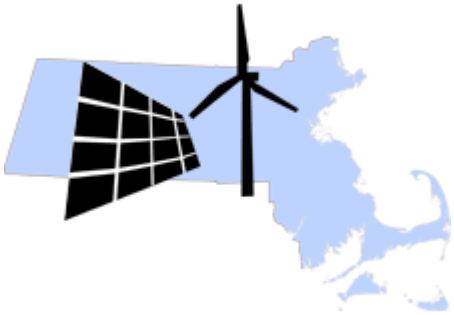
Equity issues: Not significant, due to low incremental cost of attaining higher efficiency standards.

Experience in other states: This is a nationwide program.

Legal authority: The federal government has preempted authority over efficiency standards for products; states can apply for waivers.

Implementation issues: None known.

Uncertainty: Energy savings per product are dependable due to mass production and quality standards. Durability of products can be an issue, and higher frequency of replacements would reduce energy savings due to the embodied energy in manufacturing of products.



Electricity Supply

The vast majority of existing power plants burn fossil fuels to generate electricity, producing millions of tons of pollution. Additional electricity generation technologies include nuclear, hydro, wind, solar, and eligible biomass, which vary in their emissions profiles. The character of the electric power sector as a whole is determined by three key factors: the demand for electricity across sectors, existing generation capacity by technology type, and actual generation, which depends on how much of each type of existing capacity is utilized to meet demand. There are several approaches related to each of these factors that can push the Commonwealth toward a clean energy future for electricity supply.

Demand for electricity can be reduced by improving the energy efficiency of our end-use devices, such as refrigerators and office equipment, as is discussed in the buildings section of this Plan. Both generating capacity and actual generation of clean energy technologies can be increased by a spectrum of activities based on the maturity of the technology.[36] Grants and other direct investments are best suited for research and development and early-stage companies or projects. A Renewable Energy Portfolio Standard can create market demand for all qualifying technologies, while specific requirements for particular technologies can target support for emerging technologies. By setting a price for carbon dioxide emissions from power plants by auction, the Regional Greenhouse Gas Initiative (RGGI) provides the power generating market with a transparent, stable, technology-neutral signal that influences both new investments and current operations. And implementation of Federal Clean Air Act rules encourages generators to retire or upgrade their dirtiest plants.

In order to achieve the GHG emission limit set by the Secretary, the *Massachusetts Clean Energy and Climate Plan for 2020* relies on progress in each of these areas made since 2007, along with proposed new measures to move toward a cleaner electricity supply.

Massachusetts Clean Energy Center

The Green Jobs Act of 2008 created the MassCEC to accelerate job growth and economic development in the state's clean energy industry. MassCEC serves as a clearinghouse and support center for the clean energy sector, making direct investments in new and existing technologies, clean energy companies, and workforce development to meet the skill needs of this growing industry.

In November 2009, an Act Relative to Clean Energy transferred the state's Renewable Energy Trust Fund to MassCEC. The Trust Fund was created in 1998 by the Legislature to provide financial assistance for development of renewable energy projects. With funds and programs to support clean energy development, entrepreneurship,

[36] A framework for effective clean electricity policies by technology/market maturity has been developed by the International Energy Agency. http://www.iea.org/Textbase/npsum/DeployRenew2008SUM.pdf

workforce development, and installation, MassCEC is a unique one-stop shop for growing a clean energy economy.

Renewable Portfolio Standard

The RPS is used in more than 20 states and in other countries to create demand for renewable energy technologies such as wind, solar, biomass, and small hydro that are not yet price competitive with conventional power sources.[37] In Massachusetts, retail sellers of electricity are required to obtain a growing share of their supply from new renewable sources, thereby creating a demand for new projects. The eligible renewable resources are categorized into "classes" of similar maturity and type ("technology banding"). For example, wind, eligible biomass and anaerobic digestion, and small hydro are all in Class I while solar is carved out into a separate class. Beginning in 2003, the share of total electricity supply required to come from Class I resources increased one-half percent a year, reaching 4 percent in 2009. Starting in 2010, the required percentage increased by 1 percent a year, and will rise to 15 percent by 2020.

In addition to requiring increasing amounts of renewables in the market, the Department of Energy Resources (DOER) has taken steps to assure that the kind of renewables that receive state incentives produce GHG savings over time. In 2009, DOER commissioned a study from the Manomet Center for Conservation Sciences to explore the lifecycle GHG implications of biomass energy plants. The results of the study, published in 2010, questioned long-held assumptions about the carbon-neutrality of biomass electricity technologies, and DOER is currently in the midst of finalizing RPS regulations to assure that biomass projects are only eligible for the RPS if they yield true and substantial GHG reductions.

The Green Communities Act of 2008 (GCA) also made several other changes to further drive investment in the renewable energy market enabled by the RPS. It requires that the electric distribution companies solicit bids for long-term contracts of 10 to 15 years from new renewable energy projects. Lack of such a long-term power purchase agreement is often a stumbling block for renewable energy projects to obtain financing. In addition, operators of *distributed* renewable electricity generation such as rooftop solar panels and community wind turbines are now eligible to sell excess electricity back into the grid at the price they pay (known as "net-metering"), effectively having their electric meters turn backwards. Finally, distribution utilities were granted authority to each build and own up to 50 megawatts (MW) of solar generation. There are 11 MW underway or completed thus far.

Regional Greenhouse Gas Initiative (RGGI)

Massachusetts is one of 10 states participating in the RGGI. The initiative, which began in January 2009, establishes a region-wide constraint on CO_2 emissions from fossil fuel-fired power plants. The current program design calls for the cap to remain at the initial level for six years (2009 to 2014), and then to decrease by 2.5 percent per year for the next four years, for a total reduction of 10 percent by 2018. RGGI provides a transparent and stable signal to the electricity market to plan future investments with an understanding that higher emitting generators will need a greater number of emissions allowances than cleaner generators. Proceeds from the auction of allowances have been effectively used to fund a range of energy efficiency programs in the state, resulting in cost

[37] Large hydro dams are considered a mature technology that requires no market support and are typically not included in Renewable Portfolio Standards.

savings for residential and business consumers.

Clean Energy Imports

Canada has substantial hydro-electric resources, which have very low emissions and are available at relatively low cost, but transmission lines that deliver this resource to southern New England are currently at full capacity. One effort to tap more of this resource is the Northern Pass transmission line being developed by NSTAR and Northeast Utilities, in partnership with Hydro Quebec (HQ) and with the support of the Patrick-Murray administration. When this power line is completed, at HQ's expense, it will bring to New England enough inexpensive clean power to serve up to 15 percent of Massachusetts' present electricity demand. Additional transmission lines may also be possible.

Federal Clean Air Act Implementation

The Supreme Court, in its 2007 decision *Massachusetts vs. Environmental Protection Agency,* ordered the EPA to regulate GHG under the Clean Air Act (CAA) as "pollution which may reasonably be anticipated to endanger public health and welfare." While the CAA is federal law covering the entire country, it is largely implemented by the states, which are often better suited to understand local industries and conditions. Implementation of the CAA will provide the dirtiest power plants the choice of making upgrades in control technology of those plants or retiring them.

Cleaner Energy Performance Standard

From 2005 to 2009, the electricity portfolio serving Massachusetts became more than 20 percent cleaner. This was largely the result of how much of the time each existing power plant was operated and which fuel they utilized, rather than investment in new capacity. The major changes were the nearly complete phase-out of fuel oil by 2007 because of high oil prices, a reduction in coal operation relative to natural gas since 2007 because of low natural gas prices, and a doubling of large hydro imports into New England from Canada. These developments demonstrate that the electricity sector even as it exists can operate more cleanly.

This Plan will provide a signal to electricity suppliers to maintain and improve upon these cleaner energy portfolios by proposing a Clean Energy Standard, which would require electricity suppliers to increasingly favor low-emissions and no-emissions sources in the mix of electricity delivered to their customers. This could be designed to favor in the long-term sources like wind, solar, and hydro, which emit no GHGs, but also initially favor cleaner fossil fuels like natural gas, to act as a bridge to a clean energy future.

Existing Policy

RENEWABLE PORTFOLIO STANDARD (RPS)

Policy summary: The Massachusetts RPS was created as part of electricity restructuring in Massachusetts in 1997 and then expanded in the Green Communities Act of 2008[38]. The RPS requires retail electricity suppliers — both distribution companies and other retail suppliers — to buy a percentage of their portfolio of electricity sales from eligible resources.

Economy-wide GHG emissions reduced 2020	1.1 million metric tons, 1.2%

Clean energy economy impacts: Over the period from 2010 to 2020, the Massachusetts RPS classes will stimulate $360 million in annual investment, or $3.9 billion in cumulative investment in clean power generation that would have not occurred on its own. This is expected to create approximately 900 full-time construction jobs throughout that period.

Rationale: Because of low prices for fossil fuels, the lack of a market price for the negative impacts of pollution from fossil fuels ("externalities"), and other market barriers, the private market is not, on its own, supplying as much renewable, low-carbon power as society needs. By creating market demand, Renewable Portfolio Standards drive investments in renewable energy supply.

Policy design: The Massachusetts RPS includes "technology banding" in classes, with the Green Communities Act expanding the number of renewable classes to the following: Class 1 — New Renewables; Class 1 — Solar Carve-Out; Class 2 — Existing Renewables; and the Alternative Portfolio Standard (APS). Suppliers meet their commitments by buying Renewable Energy Credits (RECs), the accounting mechanism for ensuring that every unit of renewable energy generated is counted exactly once in terms of state requirements. As a result of the Green Communities Act, the RPS will require 15 percent of electricity supply to be from new Class 1 renewable resources, such as wind, solar, small hydro and eligible biomass and anaerobic digestion, by 2020. In total, all classes will account for 27 percent of electricity supply in that year.

GHG impact: 1.1 million tons of emissions will be avoided in 2020, from the expansion of the RPS due to the Green Communities Act, not including the RPS requirements that existed prior to the Act.

Other benefits: As with other electric sector policies, the RPS results in reduced burning of fossil fuels and therefore reduced local air pollution and improved public health. For example, a study by the independent National Research Council found that coal use around the country resulted in 20,000 premature deaths annually.[39]

Cost: There is a great deal of uncertainty in cost estimates for the RPS, due to unknown future changes in fuel prices, federal policies, and technology. Just in the last three years REC prices have dropped by a factor of three. A more detailed electricity supply study is underway. Although

[38] The GCA's annual report for 2009 has a more detailed summary and charts at: http://www.mass.gov/Eoeea/docs/doer/rps/rps+aps-2009annual-rpt.pdf

[39] Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use, National Research Council. www.nap.edu/catalog.php?record_id=12794

some renewable power is relatively high-cost, the RPS also helps to reduce electricity prices throughout New England, due to the mechanics of the regional electricity market. Power, like many other commodities, is bought and sold both under longer-term contracts and in a "spot" market. The spot market price is set by the most expensive supply needed to meet demand at a particular time. New renewable resources that have low operating costs displace the most expensive supply needed to meet demand, thereby reducing prices for all spot market power and providing savings to all customers.

Experience in other states: Twenty-four states have some type of Renewable Portfolio Standard. Key features of successful programs are those which provide transparency, longevity, and certainty to the market. Repeated changes to the program design create concern in the market.

Legal authority: RPS authority derives from electricity restructuring statues from the late 1990s as well as the Green Communities Act.

Implementation issues: The RPS (Class I) program compliance began in 2003. After several years in which eligible renewable generation fell short of requirements, and while project development continued to make progress, the program has successfully met its annual compliance obligation with new renewable energy since 2007. In 2009, the minimum standard of 5 percent was met, though an increasing portion of the generation is coming from imports from New York and adjacent Canadian provinces into the New England region.

Since the restructuring of energy markets in Massachusetts in 1997, supply contracts between the electric distribution companies and power generators have typically been for only three months to one year, far too short a period to allow financing of the high capital costs involved in developing renewable generating facilities. This has been a contributing factor in limiting supplies of RPS-eligible renewables in Massachusetts. To rectify this problem, the Green Communities Act required that the distribution companies solicit proposals from renewable energy developers and enter into cost-effective long-term contracts for at least a limited amount of renewable energy, in order to facilitate the financing of renewable energy generation. Such contracts can assist renewable energy developers in obtaining financing by providing assurance of revenues from sales of RECs and electricity over a number of years.

Uncertainty: Siting constraints both for generation nearby or for transmission to remote resources could constrain the renewable supply. In addition, restructured markets like New England may lack parties to enter into long-term power purchase agreements that are often required for financing of renewable energy projects, particularly at a time of low natural gas prices.

Existing Policy

REGIONAL GREENHOUSE GAS INITIATIVE (RGGI)

Policy summary: Massachusetts is one of the 10 Northeast and Mid-Atlantic states participating in a regional effort to limit carbon dioxide emissions from electric generating units in the region[40]. The program, which began in January 2009, establishes a region-wide cap on CO_2 emissions from fossil fuel-fired power plants in the region. The current program design calls for the cap to remain at the initial level for six years (2009 to 2014), and then to decrease at 2.5 percent per year for the next four years, for a total reduction of 10 percent by 2018.

By the end of each three-year compliance period, facilities covered under the program are required to have purchased allowances — a limited authorization to emit one ton of CO_2 — equal to their total emissions; the allowances are then retired so they cannot be used again. Allowances are made available by the states for purchase in quarterly auctions. Massachusetts is investing over 80 percent of its auction proceeds in energy efficiency, with smaller amounts for renewable energy and other consumer benefit programs.

Clean energy economy impacts: Over $120 million in auction proceeds has been invested in energy efficiency projects across the Commonwealth since 2009, creating jobs in the clean energy economy. In addition, the efficiency investments will reduce electricity and fuel costs for property owners, leaving them with savings to be invested elsewhere in the local economy.

Rationale: The electric generating sector represents approximately a quarter of total GHG emissions in Massachusetts at present. The RGGI program provides a transparent and stable signal to the electricity sector to plan for a cleaner energy future. In addition, improvements in building energy efficiency reduce the demand for electricity and help keep emissions below the cap, reducing the cost of compliance.

Policy design: Recent trends in relative fuel prices, weather, investments in energy efficiency, and the downturn in the economy have resulted in actual total regional emissions much lower than anticipated. The RGGI states, along with broad stakeholder engagement, are currently in the process of a comprehensive program review which will include evaluation of program success, program impacts, additional reductions, imports and emission leakage, and offsets.

GHG impact: RGGI has a regional emissions cap, providing for a 10 percent reduction in CO_2 emissions across the 10-state region by 2018, and there is no specific limit on emissions deriving from the power plants in a particular state. Massachusetts' significant policies for electrical energy efficiency and renewable electricity are supported, in part, by proceeds from the RGGI auctions. Therefore, in this Massachusetts-specific analysis, emissions reductions are attributed to all of these programs in combination.

Other benefits: By providing incentives for reduced operation of the dirtiest plants and greater operation of cleaner ones, the RGGI program also reduces criteria and hazardous pollutant emissions (NO_x, SO_2, mercury, and fine particulate matter). These reductions will have public health and environmental benefits.

[40] The states participating in the RGGI are CT, DE, MA, MD, ME, NH, NJ, NY, RI, VT.

Costs: Since funds received from sale of RGGI allowances are largely invested in the state's utility-administered energy efficiency programs, RGGI's costs in fractionally higher electricity prices are offset by reductions in the costs of the efficiency program.

Experience in other states: Other states are in the process of developing and implementing similar programs. These efforts include the Western Climate Initiative and the Midwest Climate Accord.

Legal authority: Massachusetts RGGI regulations derive from authority under the Green Communities Act.

Uncertainty: A range of factors affect emissions from power plants, some under the control of power plants or the state and some not, ranging from weather and relative prices of fuels used to generate electricity to the aggressiveness of the implementation of energy efficiency programs.

New Policy

MORE STRINGENT EPA POWER PLANT RULES

Policy summary: The EPA is in the midst of proposing and implementing a variety of regulations that will affect the nation's power plant fleet, impacting their allowable water and air emissions. It is likely that the owners of some older, smaller power plants will find it is not economical to retrofit their plants to meet EPA's new regulations, and they will instead choose to shut down the plants. In Massachusetts, it is possible that two of the state's older coal-fired power plants will close. The Somerset Power Station in Somerset last ran in January 2010, and its permits will eventually expire if it is not restarted. The owner of the Salem Harbor Station in Salem has indicated that it expects the plant to close within five years.[41]

Economy-wide GHG emissions reduced 2020	1.2 million metric tons; 1.2%

Rationale: Power plant emissions have severe consequences for human health.

Policy design: Among the new rules being proposed by EPA are air emissions regulations addressing the transport of power plant pollution from one state to another (Clean Air Transport Rule, or CATR). Power plants contribute to high levels of ground-level ozone and fine particulates. These rules will require significant reductions in nitrogen oxides and sulfur dioxide emissions, which will tend to favor more efficient, cleaner power plants.

The Clean Air Act also requires EPA to propose air emission limits to control the release of mercury and other hazardous substances contained in power plant fuels (National Emission Standards for Hazardous Air Pollutants) and Maximum Available Control Technology standards). In addition, under Clean Water Act Section 316(b), cooling water intake structures may need to be redesigned to minimize the adverse environmental impact associated with the entrainment of fish, shellfish and their eggs and larvae by power plants drawing in large volumes of water to condense steam used in making electricity. Finally, Coal Combustion Residuals disposal regulations will ensure the safe disposal of coal ash.

Legal authority: EPA has the authority to issue new rules under the Clean Air and Clean Water Acts.

GHG impact: If these rules result in power from two older Massachusetts power plants being displaced by natural gas-fired power plants, there would be a net 1.2 million metric ton reduction in CO_2e in 2020.

Other benefits: Reduced exposure to fine particulates and ozone will have health and environmental benefits.

[41] See http://www.boston.com/business/articles/2010/11/28/old_plant_begins_to_break_spell_over_salem_mass/

Expanded Policy

CLEAN ENERGY IMPORTS

Policy summary: Canada has substantial hydro-electric resources, which have very low emissions, and are available at relatively low cost and with no need for renewable energy subsidies (see Renewable Portfolio Standard, above). The amount of Canadian hydro has risen to 8.5 percent of New England's electric consumption, but transmission lines that deliver this resource to southern New England are at full capacity, preventing any additional Canadian hydro from getting to our market. One effort to tap more of this resource is the Northern Pass transmission line being developed by two Massachusetts utilities, NSTAR and Northeast Utilities, in partnership with Hydro Quebec (HQ) and with the support of the Patrick-Murray administration. When this power line is completed, at HQ's expense, it will bring to New England enough inexpensive clean power to serve up to 15 percent of Massachusetts' present electricity demand. Additional transmission lines may also be possible.

Clean energy economy impacts:[42] The project represents an infrastructure investment in the region by Hydro Quebec estimated at $1.1 billion. It will create hundreds of jobs related to clearing and site work, harvesting, construction and materials, including electrical, professional, and technical services. While the vast majority of these jobs will be in New Hampshire and Quebec, it is likely to have spillover effects in Massachusetts.

Economy-wide GHG emissions reduced in 2020	5.1 million metric tons, 5.4%

Rationale: Canadian hydro resources are extensive and have low operating costs. The transmission lines necessary to bring more Canadian hydropower to load centers in southern New England do not have to be financed by ratepayers apart from the price of delivered electricity, which will be sold in the competitive market.

Policy design: This policy involves working with the Massachusetts utilities to help overcome any hurdles.

GHG impact: The Northern Pass transmission line alone would provide 1,200 MW of clean electricity, enough to power nearly 1 million homes. This would result in up to 5 million tons of emissions reduction in the Commonwealth, depending on how much of the power is utilized in Massachusetts versus other states.

Other benefits: Like other electric sector policies, by incentivizing the reduced operation of fossil fuel plants, these additional low-emissions electricity imports would help reduce criteria and hazardous pollutants in the air (NOx, SO_2, mercury, and fine particulate matter). These reductions will have public health and environmental benefits. In addition, additional hydro imports will significantly improve the region's fuel diversity, improving energy security and price stability.

Cost: There are no additional costs to this effort to ratepayers or taxpayers. The power is expected to be sold in the market. In fact, as a "price-taker" in the market, it is possible that it would lower the wholesale electricity price and therefore reduce costs for business and residential

[42] www.northernpass.us/transmission_project_impact.pdf

consumers. According to Northeast Utilities, a comprehensive analysis by Charles River Associates (CRA) shows that, even with conservative assumptions, the Northern Pass line will reduce energy prices in the wholesale market, potentially saving New England customers $200 million to $300 million in annual energy costs.

Experience in other states: Massachusetts and other Northeast states already have transmission lines to Canada and have imported hydro power for years. In fact, additional hydro power imports have been a significant contributor to a cleaner New England electricity grid in the last five years.

Legal authority: DPU and DOER have already begun working with utilities and ISO-New England on increasing such imports.

Uncertainty: Transmission lines involve federal, state and local permitting, and often raise siting concerns, with potential delays from legal action.

New Policy

CLEAN ENERGY PERFORMANCE STANDARD (CPS)

Policy summary: From 2005 to 2009, the electricity portfolio serving Massachusetts became nearly 20 percent cleaner. The major changes came from substitution of natural gas for coal and oil, doubling of imports of hydro power from Canada into New England, and the up-rating — or increasing of capacity — of existing nuclear plants regionally. This demonstrated that mature technologies have made a significant contribution to a cleaner electricity grid, without the federal or state incentives required for developing earlier stage technologies. They have an important role to play moving forward.

A market-based framework is needed to provide a clear signal to the electricity market to improve upon the cleaner energy portfolios of the last few years and to encourage projects such as the Northern Pass line (see "Clean Energy Imports" above). One approach to be considered is a Clean Energy Performance Standard (CPS), which applies an output-based performance standard to either portfolios of retail electricity sellers or to generators in terms of tons of pollution per megawatt-hour of electricity. As the performance standard becomes more stringent over time, the electricity market uses the least-cost mechanism for meeting it. The existing RPS fits neatly into this framework as a technology-specific means of meeting the standard.

Clean energy economy impacts: The CPS is a transparent and stable market-based framework that provides market certainty and enables investments to be made. It would encourage further replacement of power plant capital stock with cleaner technologies and cleaner fuels while disadvantaging dirtier power plants in the electricity marketplace.

Rationale: By being performance-based rather than technology-based, the CPS allows the market to find the least-cost approach to achieving a cleaner energy portfolio. In addition, it could empower electricity suppliers to manage their portfolios, akin to the CAFE standard for vehicles, offering cleaner products to interested customers to help meet their portfolio targets.

Policy design: Design issues include setting the targets; creating tracking mechanisms, particularly for system power; allowing tradability among suppliers, and minimizing "shuffling," in which generators shift cleaner power to Massachusetts and dirtier power to other states. Resolving these and other design issues would require substantial consultation with the electricity industry.

GHG impact: The potential GHG impacts are substantial; however, they are completely dependent on the targets set and include the impacts from both the RPS and the clean energy imports. Therefore no additional GHG reductions from this potential policy were included in the overall estimates.

Other benefits: Like other electric sector policies, by providing incentives for the reduced operation of the dirtiest plants and greater operation of cleaner ones, a CPS reduces criteria and hazardous pollutant emissions (NO_x, SO_2, mercury, and fine particulate matter). These reductions will have public health and environmental benefits.

Cost: In the near-term, a CPS is likely to have a limited impact on electricity prices for consumers. [43]

Experience in other states: Generator-level performance standards for new generators have recently been considered or implemented in several states and countries. However, portfolio-level performance standards for retail sellers of electricity or tradable performance standards for existing plants are less common, but have been analyzed recently. California has been working on a preferred loading order meant to encourage dispatch of lower emissions resources.

Legal authority: DOER and DPU will begin analysis of possible paths forward for creating a CPS, including regulatory or legislative avenues, as well as cost-benefit and implementation issues.

Uncertainty: The CPS ensures a cleaner energy portfolio over time. However, since it sets a limit on the carbon intensity of electricity generation, it does not constrain overall emissions. For example, if demand growth exceeded expectations, overall emissions would grow. Effective implementation of energy efficiency policies are a critical complement to mitigate this risk.

[43] Carolyn Fischer and Richard G. Newell, "Environmental and Technology Policies for Climate Mitigation". http://rff.org/rff/Documents/RFF-DP-04-05-REV.pdf

Transportation

Transportation is second only to buildings in responsibility for GHG emissions in the state, and is a fast-growing emissions sector. The vast majority of emissions come from cars and trucks, although air travel is a rapidly rising emissions source. There are several means of addressing transportation emissions, all of which Massachusetts has been pursuing — improving vehicle efficiency, moderating the growth in auto travel through providing alternatives to it, and promoting the development and use of vehicle fuels that yield lower GHG emissions than petroleum-based fuels. The *Massachusetts Clean Energy and Climate Plan for 2020* takes into account state and federal measures to improve vehicle efficiency, reduce vehicle miles traveled, and increase use of lower-carbon fuels, and proposes additional measures that will contribute toward meeting the 2020 limit.

Improving Vehicle Efficiency

Improving vehicle efficiency has been primarily a federal government responsibility, implemented through Corporate Average Fuel Economy (CAFE) standards first put forth in 1975 by the National Highway Traffic and Safety Administration (NHTSA). These standards had been stagnant for many years, but were raised in the 2007 federal Energy Independence and Security Act. Under President Obama, the standards were raised sharply in 2010, from 27.5 miles per gallon currently to 35.5 MPG (in 2016), and for the first time NHTSA and the Environmental Protection Agency (EPA) issued joint regulations that will control both fuel efficiency and GHG emissions from cars and light trucks.

During the period when federal CAFE standards were stagnant, the state of California passed its own law to regulate GHG emissions from light vehicles, under a longstanding waiver provision of the federal Clean Air Act. Massachusetts law requires adoption of California's standards if they are stricter than the federal ones, and the Commonwealth did so in December 2005. These standards apply to model year 2009 and newer vehicles. However, the federal government requires California to obtain a waiver of federal law in order to impose its own emission standards. In 2007 EPA denied California's waiver request, although it was later approved under President Obama.

In October 2010, NHTSA and EPA announced that they would propose regulations to require improved efficiency and lower GHG emissions from medium- and heavy-duty vehicles, including delivery trucks, buses and semi trucks (tractor trailers). These will also yield substantial GHG reductions in Massachusetts.

This Plan proposes a complementary measure to improve the overall efficiency of light-duty vehicles in Massachusetts: providing incentives to consumers to purchase more fuel-efficient vehicles. Such incentives would involve varying charges and/or rebates on vehicles according to their GHG emissions per mile (similar to fuel use per mile) — such as varying the sales tax on new cars, the annual vehicle excise tax, or registration fees. The variable charges could be designed to be revenue-neutral to consumers as a whole and to the state, with tax increases and decreases balancing each other.

Reducing Vehicle Miles Travelled (VMT)

Massachusetts has a number of programs to rein in the growth of driving, which is generally measured by vehicle miles traveled (VMT). Most of these programs have as their primary purposes improving mobility options for state residents by providing alternative methods of travel and reducing congestion on the roads, and reducing air pollutants that damage human health, such as nitrogen oxides, carbon monoxide, and particulates. Among these are support for public transit and for infrastructure that improves conditions for bicyclists and pedestrians. The state also operates programs that encourage ride-sharing among commuters, van pooling, and employer-based methods for reducing single-occupancy travel to work.

The amount of driving is greatly influenced by patterns of new housing and business development in the state. The more spread out development is, the more driving people must do to get to work and school, to shop and participate in other activities. Although decisions on development are primarily up to local governments and the private sector, the state has several policies designed to influence them. The state has issued *Sustainable Development Principles* to guide state agency programs, as well as investment in land and infrastructure. The principles call for encouraging building homes "near jobs, transit, and where services are available," and encourage the creation of pedestrian-friendly neighborhoods — practices known as "smart growth". Adherence to the principles is aided by the Commonwealth Capital program, under which about $600 million annually in grants and loans for municipalities is distributed in part on the basis of communities meeting sustainable development criteria.

The Massachusetts Department of Transportation (MassDOT) took a major step forward in June, 2010 with its "GreenDOT" policy directive, which commits MassDOT to "be a national leader in promoting sustainability in the transportation sector." Among the three primary goals of GreenDOT is reducing GHG emissions, in part through implementation of the Global Warming Solutions Act.[44] Critical to the specific efforts under GreenDOT is consideration of GHG impacts in statewide and regional transportation planning, and in the selection of particular projects that receive funding in the regional and statewide transportation plans.[45] GreenDOT also specifies several other efforts (to be discussed later in this Plan), such as enhanced support for alternative modes of transportation and promotion of "eco-driving" (fuel-saving auto maintenance and driving practices). GHG emissions from auto travel can also be reduced by enabling more efficient roadway operation through the use of intelligent transportation systems and mitigating "bottlenecks" that create local congestion, if such mitigation is designed so that it does not expand overall system capacity, facilitate increased auto travel, nor increase GHG emissions over time.

This Plan proposes several new policies to aid in the effort to limit miles traveled. First, an extension of policies to steer new development toward smart growth — through a new law designed to improve local zoning, provide assistance to communities to help them develop zoning policies, and require that state infrastructure funding

[44] MassDOT Policy Directive on GreenDOT, Jeffrey B. Mullan, Secretary of Transportation, June 2, 2010.

[45] Although Green DOT is now an "existing" state policy, it was released subsequent to completion of ERG's February 2010 report on the impacts of the state's current GHG reduction policies, and so was not included in those numerical estimates. Therefore in the present document the impacts of GreenDOT are treated as "new" policies.

decisions take into account impacts on GHG emissions.

Second, the Plan proposes that the state implement a pilot program of "Pay As You Drive" (PAYD) auto insurance, with the possibility of its expansion later. PAYD is an innovation that many studies have shown would significantly reduce miles driven,[46] by converting a fixed annual cost into a cost that varies by the amount of driving. In addition, average insurance costs across all drivers would fall, as less driving also means fewer accidents, and there would be significant reductions in traffic congestion, particularly in urban areas.

Reducing the Carbon Content of Vehicle Fuel

Emissions controls on cars have greatly cut emissions of health-damaging pollutants such as nitrogen dioxide. But such controls are unable to reduce carbon dioxide emissions from petroleum fuels, the primary GHG pollutant. As a result, to limit the GHG emissions from vehicle fuel, it is necessary to find alternatives to gasoline and petroleum-based diesel fuel, such as bio-diesel, ethanol, natural gas, and electricity.

In recent years, the actual GHG benefits of liquid biofuels made from food crops, such as corn-based ethanol and soy-based bio-diesel, have been questioned. When one examines the entire lifecycle of such fuels, including their impacts on food supplies and deforestation, it is unclear whether and to what degree GHG emissions are reduced compared to petroleum fuels. As a result, Massachusetts has concentrated its efforts on supporting non-food crop based or "advanced" biofuels, and has required that alternatives to petroleum demonstrate significant GHG benefits.

In 2008, Governor Patrick signed the Clean Energy Biofuels Act, which has several parts. First, it exempts non-food crop based, or cellulosic, biofuel from the state's gasoline tax. Second, it requires that initially 2 percent of the diesel fuel and home heating fuel sold in the state consist of bio-diesel, rising to 5 percent in 2013. However, the bio-diesel must be shown to yield a 50 percent reduction in GHG emissions compared to petroleum diesel. A lack of supply of such fuel, along with other obstacles to implementation, have caused the state to delay implementation of the content mandate. Third, the Act instructs the state to pursue development of a "low carbon fuel standard" (LCFS) on a regional basis throughout the Northeast. The LCFS concept originated in California, where the legal target is to reduce the average carbon content of motor fuel 10 percent by 2020. During the past two years Massachusetts has been leading an effort by the Northeast and Mid-Atlantic states to construct such a standard. A target for the Northeast/Mid-Atlantic LCFS has not been set.

In addition, two federal laws are designed to bring more alternative fuels into the market. First, Title II of the federal Energy Independence and Security Act of 2007 creates a "renewable fuel standard," which requires that such fuel used in the U.S. will rise from 4.7 billion gallons in 2007 to 36 billion gallons in 2022. Of that, "advanced biofuel" must rise from 0.6 billion gallons in 2009 to 21 billion gallons in 2022, and cellulosic biofuel must rise from 0.1 billion gallons in 2010 to 16 billion gallons in 2022. Renewable fuels must be produced from

[46] See, for example, "Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity," Jason E. Bordoff and Pascal J. Noel, The Hamilton Project, The Brookings Institution, July, 2008; Pay-As-You-Drive Auto Insurance In Massachusetts: A Risk Assessment And Report On Consumer, Industry And Environmental Benefits, MIT Professor Joseph Ferreira, Jr. & Eric Minikel Commissioned by Conservation Law Foundation & Environmental Insurance Agency, November 2010.

renewable biomass, replace other transportation fuel, and achieve at least a 20 percent reduction in GHG emissions on a lifecycle basis for "new facilities." (Existing facilities, such as those producing corn-based ethanol, and their expansion are exempt from the GHG criterion.) Advanced biofuel excludes ethanol derived from corn starch, and must yield at least a 50 percent lifecycle reduction in GHG emissions, while cellulosic biofuel must achieve a 60 percent reduction.

Second, the federal Energy Improvement and Extension Act of 2008 provides a $2,500 tax credit for the first 250,000 light-duty plug-in hybrid electric vehicles sold until 2015, requiring that each must have a battery capacity of at least 4 kW. The tax credit rises with battery capacity to a maximum of $7,500.

This Plan relies primarily on development of a regional Low Carbon Fuel Standard, along with the federal policies described above, to obtain reductions in the average carbon content of vehicle fuels; which constitutes one of the three main methods of reducing GHG emissions from transportation.

Existing Policy

Federal and California Vehicle Efficiency and GHG Standards

Policy Summary: The EPA and the National Highway Traffic Safety Administration (NHTSA) have set harmonized standards for light-duty vehicle MPG and GHG emissions for model year 2012 through 2016 vehicles. The standard is raised from 27.5 MPG at present to 35.5 MPG in 2016. California has harmonized its standards with the federal standards through 2016, but is expected to propose stricter standards for model year 2017 to 2020 vehicles, and Massachusetts law requires the Commonwealth to adopt the California standards. In combination, the EPA and California standards are forecast to yield a 17 percent reduction in GHG emissions in 2020 (primarily from lower gasoline consumption, but also with some reduced emissions from vehicle air conditioning systems).

Economy-wide GHG emissions reduced in 2020	2.4 million metric tons; 2.6%
Cumulative net benefits discounted, 2012-lifetime of vehicles (fuel savings and other social benefits, less increased vehicle costs)	$8.0 billion
Jobs gained in 2020 (direct and indirect)	6,200 jobs

Note: benefits are calculated over the lifetimes of vehicles purchased from 2012 through 2020, which extend beyond 2020.

Clean energy economy impacts: The vast majority of spending on motor fuel goes out of state, so reducing those expenditures by billions of dollars means more money can be spent on in-state businesses, stimulating the economy and creating jobs.

Rationale: Federal fuel economy (CAFE) standards were first enacted in 1975 but have been relatively stagnant since the 1980s. Federal law raised them in 2007, but the Obama administration proposed an accelerated schedule through 2016. Improving the fuel economy of vehicles is one of the most effective tools to reduce energy consumption and GHG emissions.

Design issues: The federal regulations continue the practice of having different standards for cars and light trucks, although two-wheel drive SUVs will be reclassified as cars. EPA/NHTSA project the fraction of vehicles sold in the two categories; average MPG and fuel savings could be lower than expected if a higher proportion of light trucks are sold.

GHG impact: 2.4 million tons in 2020 for Massachusetts, based on EPA/NHTSA and California projections.

Other benefits: EPA's benefit calculations include lower air pollution from vehicles, less time spent refueling, security benefits of lower petroleum imports, and the social value of lower carbon emissions.

Costs: About $3.4 billion in additional vehicle costs through 2020, far outweighed by $11.4 billion in reduced fuel costs (all in net present value).

Equity issues: Both higher initial capital costs and subsequent fuel savings will accrue first to purchasers of new vehicles. Lower income drivers more commonly buy used vehicles, and will only be affected in later years as the new models are sold on the used car market.

Experience in other states: The federal regulations are required in all states. Massachusetts and a number of other states have adopted California's stricter standards in the past, with no implementation problems.

Legal authority: The federal government has authority over vehicle efficiency and air emissions. However, there is an exemption under the 1970 Clean Air Act for California to adopt standards stricter than EPA's (if awarded a waiver by EPA) and for other states to adopt California's standards.

Implementation issues: None.

Uncertainty: See discussion under "design issues" concerning the distribution of sales between cars and light trucks.

New Policy

Federal Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles

Policy summary: The EPA and the DOT have announced complementary programs to reduce GHG emissions and improve fuel efficiency, respectively, for medium- and heavy-duty vehicles, such as the largest pickup trucks and vans, combination tractors[47], and all types and size of work trucks and buses in between, for model years 2014-2018.

Economy-wide GHG emissions reduced in 2020	0.3 million metric tons; 0.3%
Motor fuel savings in 2020[48]	$140 million per year
Cumulative net benefits (discounted) 2011-lifetime of vehicles	$240 million
Jobs gained in 2020 (direct and indirect)	1,000 jobs

Clean energy economy impacts: Using commercially available technologies, a payback period of one to two years is estimated for the majority of vehicles. Vehicles with lower annual miles would have payback periods of four to five years. For example, an operator of a semi truck could pay for the technology upgrades in under a year, and have net savings up to $74,000 over the truck's useful life.[49] Large reductions in fuel use will improve air quality. Less spending on imported fuel will keep more money in the Massachusetts economy and thereby create jobs.

Rationale: Transportation is projected to account for close to 40 percent of total GHG emissions in Massachusetts in 2020, and medium- and heavy-duty vehicles are projected to account for 13 percent of transportation sector emissions. These vehicle standards will reduce fuel consumption and GHG emissions while providing regulatory certainty for manufacturers.

GHG impact: 0.34 percent of statewide GHG emissions in 2020, based on a reduction of 6.4 percent in emissions from medium- and heavy-duty vehicles.

Equity issues: The federal regulations are carefully designed to set efficiency standards that are appropriate and cost-effective for different sizes and types of vehicles. There are no significant predicted equity issues with the promulgation of this federal regulation.

Uncertainty: Current projections of the impact of these standards by the EPA and NHTSA may not turn out to be correct, in terms of fuel savings and costs and benefits, as the regulation is not final. In addition, if manufacturers cannot meet the standard and pay penalties instead, then GHG and fuel consumption targets will not be met.

[47] Also known as semi trucks that typically pull trailers.

[48] At $3.34/gallon gasoline, $3.51/gallon diesel, in 2008$. Energy Information Administration, Annual Energy Outlook 2010.

[49] "EPA and NHTSA Propose First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles: Regulatory Announcement," Report No. EPA-420-F-10-901, October 2010.

Existing Policy

Federal Renewable Fuel Standard and Regional Low Carbon Fuel Standard

Policy summary: Title II of the federal Energy Independence and Security Act of 2007 creates a "renewable fuel standard," which requires that the volume of renewable fuels used in the U.S. will rise from 4.7 billion gallons in 2007 to 36 billion gallons in 2022. In a similar fashion, Massachusetts' biofuels law, passed in 2008, instructs the state to pursue development of a "low carbon fuel standard" (LCFS) on a regional basis throughout the Northeast. The LCFS (first developed by California) would require that the average carbon intensity of vehicle fuels fall by a specific percentage compared to petroleum fuels.

Economy-wide GHG emissions reduced in 2020	1.5 million metric tons; 1.6%

Clean energy economy impacts: To the degree that imported petroleum used in Massachusetts can be replaced by feedstocks such as solid waste, forest residues, and other cellulosic material, money that would otherwise go overseas is retained in the regional economy. If advanced fuels (including electricity powering plug-in hybrid and all-electric vehicles) eventually become less expensive than petroleum fuels, consumer costs are expected to fall. There are significant economic development opportunities in growing feedstocks, converting those into fuel, and in research and development. The report of the Massachusetts Advanced Biofuels Task Force forecast that the sector could employ 2,500 people in the state by 2025.

Rationale: The carbon intensity (or GHG emissions per unit of energy used) of fuel is one of the three main ways that emissions from motor vehicles can be reduced. In theory, if crops or other plants are used to produce fuel, the emissions from burning the fuel can be canceled out by the re-growth of plants on the same land absorbing equal amounts of carbon dioxide during its growth. Given the United States' large supply of land and agricultural produce, this is a logical method of reducing the use of petroleum. In addition, if electric vehicles become prominent, they would reduce the carbon intensity of fuels, since electric motors are far more efficient at powering motor vehicles than are gasoline engines.

Policy design and issues: Under the Federal RFS, supplies of "advanced biofuel" (including cellulosic) must rise from 0.6 billion gallons in 2009 to 21 billion gallons in 2022, and cellulosic biofuel by itself must rise to 16 billion gallons in 2022. Advanced biofuel excludes ethanol derived from corn starch, and must yield at least a 50 percent lifecycle reduction in GHG emissions, while cellulosic biofuel must achieve a 60 percent reduction. Renewable fuels that don't qualify as advanced can constitute up to 15 billion out of the 36 billion total gallons of fuel; they must still be produced from renewable biomass, replace other transportation fuel, and achieve at least a 20 percent reduction in GHG emissions on a lifecycle basis for "new facilities." Existing facilities, and expansion of such facilities, such as those producing corn-based ethanol, are exempt from the GHG criterion, leaving some question as to how much of the non-advanced fuel will actually meet the 20 percent criterion.

As required by the Biofuels Act, during the past two years Massachusetts has been leading an effort by the Northeast and Mid-Atlantic states to develop a Low Carbon Fuel Standard in the region. The LCFS concept originated in California, where regulations require a reduction in the

average carbon content of motor fuel of 10 percent by 2020. Targets and timelines for the Northeast/Mid-Atlantic LCFS are being developed. Unlike the RFS, the LCFS is a "technology neutral" standard — rather than requiring specific volumes of different fuels, it allows fuel suppliers to choose any motor fuel in any quantity — including petroleum, biofuels, natural gas, electricity, and other possibilities. First, the average carbon intensity of each fuel is determined. If the intensity of a particular fuel exceeds the annual target, then suppliers of this fuel have a "deficit" and must purchase credits from sellers of fuels that have a carbon intensity below the annual target.

A major issue for the RFS and the LCFS is calculating the carbon intensity of different fuels. This requires examining the entire lifecycle of a fuel, including, for example, how electricity is generated and how crops are grown — calculations that are difficult to do with any degree of precision. Important numerically, and controversial, are the carbon impacts from what is known as "indirect land use change" (ILUC). When large amounts of food crops are used for fuel (corn for ethanol, soybeans or rapeseed for biodiesel), this may cause the need for more food production. Forests may be cut down to expand the amount of land on which crops can be grown, causing reductions in the CO_2 sequestered by trees and soil. The US EPA and the California Air Resources Board (CARB), along with the European Union and specific European countries, are currently calculating ILUC for each fuel, but each source has published different numbers. The Northeast and Mid-Atlantic states are examining which methodologies and figures are best to use, and these choices substantially affect how much "credit" each fuel would receive under the LCFS.

There are a number of other design issues involved in constructing a regional LCFS for the 11 states currently involved, and an interstate group of agency staff, along with an interstate agency — the Northeast States for Coordinated Air Use Management (NESCAUM) — have been addressing design issues for the past two years.

GHG impact: For purposes of this Plan, the LCFS is estimated conservatively to achieve a 5 percent reduction in the average carbon content of vehicle fuel by 2020, with greater reductions in following years. The LCFS is more specifically focused on GHG reductions than the federal RFS. Without the LCFS, the RFS by itself might yield about a 3 percent reduction, depending on what reductions are actually achieved from corn-based ethanol produced throughout the U.S.

Other benefits: Possible reductions in other air pollutants, depending on which fuels are used in place of petroleum.

Costs: NESCAUM is working on a regional economic analysis which will be available in early 2011. This analysis will include estimates of cost and benefits to the region and to each state.

Equity issues: Any price impacts from the RFS and LCFS will be spread across all drivers in proportion to the amount of fuel that they use.

Experience in other states: California has adopted regulations for implementation of its LCFS, which goes into effect in 2011.

Legal authority: Massachusetts' biofuels law gives the state the authority to implement the LCFS. In other participating states, new regulations or legislation will be necessary, or both.

Implementation issues: As with any interstate policy, achieving agreement on how to implement a uniform policy among a number of states presents many complexities. The

interstate effort currently underway, led by Massachusetts and NESCAUM, is addressing these. For example, distribution infrastructure for new fuels and vehicles may be needed. This would require large capital investments (e.g., liquid fuel distribution for biofuels, charging stations for electricity, etc.) and it is unclear whether the incentive system created by the LCFS will be sufficient to draw out that investment. Nor is it clear whether the auto manufacturers will develop the vehicles needed to utilize the fuel, particularly in the case of plug-in hybrid and all-electric vehicles. Complementary policies may be necessary for all parts of the system to be developed in tandem.

Uncertainty: As a technology-neutral policy, the LCFS is not picking between the several possibilities for alternatives to petroleum, and it is uncertain at this time which ones will succeed best in terms of eventual cost, and what that cost will be.

New Policy

CLEAN CAR CONSUMER INCENTIVES

Policy summary: There are various means by which the Commonwealth could provide incentives for consumers to shift their vehicle purchases to more fuel-efficient (or lower GHG) models. This includes varying the rates on new car sales taxes, annual auto excise (property) taxes, and registration fees, with rates raised on low-MPG vehicles and reduced on high-MPG ones. The change could be designed to be revenue-neutral to consumers as a whole and to the state.

Economy-wide GHG emissions reduced in 2020	0.2 - 0.4 million metric tons; 0.2% - 0.5%
Motor fuel savings (at $3.34/gallon[50]) in 2020	$110 - $230 million
Cumulative net benefits (discounted) 2011-2020 for higher end of annual benefits	$570 million
Jobs gained in 2020 (direct and indirect)	1,700 jobs

Clean energy economy impacts: Large reductions in fuel costs for consumers, and less spending on imported fuel, which keeps more money in the Massachusetts economy and thereby creates jobs. For a tax or fee that varies with CO_2 but is still a percentage of vehicle price or value, and is revenue neutral to the state, costs would fall for a majority of auto buyers or owners (possibly around 60 percent), because the most expensive vehicles also tend to get the worst MPG and these would bring in much greater revenues.

Rationale: Transportation is expected to account for close to 40 percent of total GHG emissions in Massachusetts in 2020, and light vehicles by themselves (cars, SUVs, minivans, pickups) around 28 percent of the total. The efficiency of the vehicles themselves is probably the easiest factor to influence among the several that determine vehicle emissions (the others being miles traveled and carbon content of the fuel). Although the federal government preempts authority over setting efficiency standards for automakers, the state does have the ability to influence consumer choice through tax and fee policies. Given the state's budget realities, a policy that combines incentives and disincentives can be accomplished without a loss of tax revenue.

Design issues: The simplest design, which has been proposed in California and Europe, is a charge measured in cents per gram of carbon per mile driven, or cents per gallon per mile driven, varying linearly from a minimum to a maximum rate. This would provide the strongest incentive, but would not be tied to the price of the vehicle. A tax or fee that varied by carbon emissions but was a percentage of vehicle sales price or current value (for vehicle property taxes or registration fees) would concentrate the impact on buyers of more expensive vehicles, but would provide a weaker incentive to buy fuel-efficient vehicles.

In addition, there could be rate variations designed to assist particular groups of drivers, such as those with large families who need vehicles with seating capacity for six or more, or contractors who need trucks for their businesses.

The tax or fee design could be revenue-neutral to the state and to consumers as a whole, with reductions and increases in payments balancing out. The sales tax on motor vehicles in

[50] EIA forecast for 2020, in constant 2009 dollars.

Massachusetts is currently 6.25 percent, as for all non-exempt products. Preliminary modeling by the state, with the rates varying from 0 percent to twice the current sales tax rate, found that expensive, low-MPG vehicles would yield a large tax revenue increase. In order to maintain revenue neutrality, the entire tax schedule would shift down, with the most efficient vehicles (hybrids) having a negative rate (receiving a rebate) while the top rate would be significantly below 12.5 percent.

GHG impact: For a variable sales tax, the impact would vary from around 0.2 million to 0.4 million metric tons, due to an improvement of 1 percent to 2 percent in average vehicle fuel efficiency, as estimated by Cambridge Systematics, Inc. For a change to vehicle excise taxes or registration fees, the dollar amounts are lower and the impact would be lower. In the table above, the larger impact is from a straight fee on CO_2 emitted per mile driven, that replaces the current sales tax, as has been proposed by California. The smaller impact is from a fee that varies according to CO_2 emissions but is a percentage of vehicle purchase price.

Other benefits: Fewer large, heavy vehicles on the road will reduce injury and death rates from accidents. Reduced fuel usage will cut emissions of other air pollutants that cause human health damage.

Costs: Minimal costs to administer. The state would devise tax or fee rate schedules and provide these to auto dealers or the Registry of Motor Vehicles (RMV). Dealers already handle the sales tax through an electronic connection to the RMV.

Equity issues: Lower-income households tend to buy used cars, whose sales tax rates will not change under this proposal. For new vehicles, size, weight and gas consumption are highly correlated with purchase price, so the tax increases will tend to be felt by higher-income purchasers, with buyers of smaller, cheaper cars seeing decreases in their sales taxes. Beyond the initial purchase price, virtually all drivers whose vehicle choice is modified by the incentive mechanism will see substantial savings in gasoline costs over time.

Experience in other states: California has proposed a version of the sliding-scale sales tax, with the tax varying directly with CO_2 emissions, in their climate planning process, and legislation is pending.

Legal authority: Legislation is required to change the tax rates. In some cases, fees such as registration fees can be changed by agencies without new legislation. EEA and MassDOT will conduct a study to examine critical implementation challenges and possible regulatory or legislative paths forward.

Implementation issues: Changes will be needed to the RMV's computer systems. In order to maintain revenue neutrality, it will probably be necessary to adjust fees, rebates or tax rates over time.

Uncertainty: The degree of consumer response to changes in taxes or fees is not precisely known, so the gains in reduced emissions and the exact tax revenues will only be seen with experience.

New Policy

PAY AS YOU DRIVE (PAYD) AUTO INSURANCE PILOT

Policy Summary: PAYD would convert a large fixed annual premium into a variable cost based on miles traveled, creating a major incentive to reduce discretionary driving, while cutting the overall cost of insurance due to fewer accidents. Miles driven would fall substantially, along with CO_2 emissions and costs for gasoline, accidents, and congestion. The Commonwealth plans to conduct a PAYD pilot program initially, and, depending on results, consider working with the insurance industry to make this payment method more widely available in future years. Benefits from PAYD would depend on its degree of adoption by insurance companies and consumers.

Benefits from full-scale PAYD implementation

Economy-wide GHG emissions reduced	0.4 - 2.0 million metric tons; 0.4% - 2.1%
Motor fuel savings (at $3.34/gallon) in 2020	$160 - $830 million
Accident savings (medical costs, property damage, etc.) and reductions in insurance premiums in 2020	$160 - $800 million
Congestion savings (reduction in lost time) in 2020	$50 - $250 million
Total $ savings 2020	$370 - $1,880 million
$ savings per person in the state 2020	$60 - $290
Cumulative net benefits discounted 2011-2020 (for middle option)	$5.3 billion
Jobs gained in 2020 (middle policy option, direct and indirect)	2,500 jobs

Note: The lower end of the benefits range is for a voluntary system, higher end is for a mandatory system with the entire insurance charge on a per-mile basis. A middle option, with a mandatory system that has a flat charge for the first 2,000 miles and a per-mile charge beyond that, would yield about 1.0 million tons GHG reduction in 2020, from a 5 percent reduction in vehicle miles traveled.

Clean energy economy impacts: For a reduction of 5 percent in VMT (middle policy option), motor fuel spending would fall by $440 million at 2020 projected gas prices. Less spending on imported fuel will keep more money in the Massachusetts economy and thereby create jobs. A Brookings Institution study estimated that rates would fall for two-thirds of drivers, while rising for one-third. Benefits would accrue particularly to lower-income drivers, who need a vehicle for employment but can save money by controlling non-essential driving. Less congestion will improve quality of life.

Rationale: Transportation is expected to account for close to 40 percent of total GHG emissions in Massachusetts in 2020, and light vehicles by themselves (cars, SUVs, minivans, pickups) around 28 percent of the total. One way to reduce emissions is by reducing VMT. At present, insurance premiums do not vary by VMT (though there is precedent in current discounts for low usage, such as 5,000 miles/year) and so they have little impact on people's driving habits. If insurance were converted into a per-mile charge it would give drivers a new incentive to limit their driving when they can.

Design issues: Design of the program would depend upon the results of the pilot program. It is expected that the per-mile rate would not be uniform, but rather would vary by the traditional

rating factors, including location and driver experience. Thus, miles driven would only be one factor determining rates. For example, an inexperienced driver living in Boston would likely pay a per mile rate substantially higher than that of an experienced driver living in western Massachusetts. Because insurance companies set their rates by accident costs within a geographic area, PAYD would not favor urban residents over suburban or rural ones. PAYD would be "revenue neutral" within a particular area, favoring low-mileage drivers over high-mileage ones.

GHG impact: 0.4 percent to 2.1 percent of statewide GHG emissions in 2020, based on a reduction of 2 percent (for a voluntary system) to 9.5 percent (for a mandatory system with charges entirely by the mile) in vehicle miles traveled. A nationwide study by the Brookings Institution found that PAYD insurance would reduce VMT by 8 percent.

Other benefits: Accidents, and the associated injuries, deaths, and monetary costs, would fall greatly, particularly in congested areas. In the middle policy option, there would be an estimated reduction in crashes of 11,000, 7,000 fewer injuries, and 36 fewer fatalities, yielding $420 million in total benefits, part of which would accrue to drivers in lower insurance rates. Congestion, and the lost time and money that result, would also fall significantly, particularly in urban areas. Cambridge Systematics, Inc. estimates that statewide congestion would be cut substantially. There would also be reductions in other air pollutants from motor vehicles, which will have health benefits.

Costs: On average, insurance costs would fall across all drivers. Costs would vary by driver, rising for high-mileage drivers who are unable to modify their driving habits. If mileage is monitored through annual safety inspections, as is done at present, there would be little additional cost for either drivers or the state. VMT could also be monitored through telematic devices in cars, which currently cost $100 to $200 per unit. These costs will probably fall as the devices become more common, and wouldn't be needed for vehicles that already have GPS systems. A gradual transition could be made by requiring the devices for new cars, but allowing use of the safety inspection data for older cars.

Equity issues: The MIT study for Massachusetts finds that accident costs are related to miles driven, and therefore having insurance rates tied to VMT improves fairness among drivers. Initially rates would increase for approximately one-third of drivers, but ultimately rates should decline for a higher fraction of all drivers due to reduced accident costs. Relative rates for different population groups — inexperienced drivers, adults, and senior citizens — would not change significantly, nor would relative rates between different areas of the state.

The most recent data available on vehicle miles traveled by income level is for 2001, and only at the national level.[51] It shows that on average middle-income families drive about three-fourths as much as high-income families, and that low-income families drive about half as much as high-income ones. A Brookings Institution study found that, nationwide, lower-income households would generally save money due to PAYD while higher-income households would, on average, pay more, as shown in Figure 7 on page 63.[52]

[51] Table A2, U.S. Per Household Vehicle-Miles Traveled, Vehicle Fuel Consumption and Expenditures, 2001," EIA.

[52] Jason E. Bordoff and Pascal J. Noel *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity,* The Brookings Institution, July 2008.

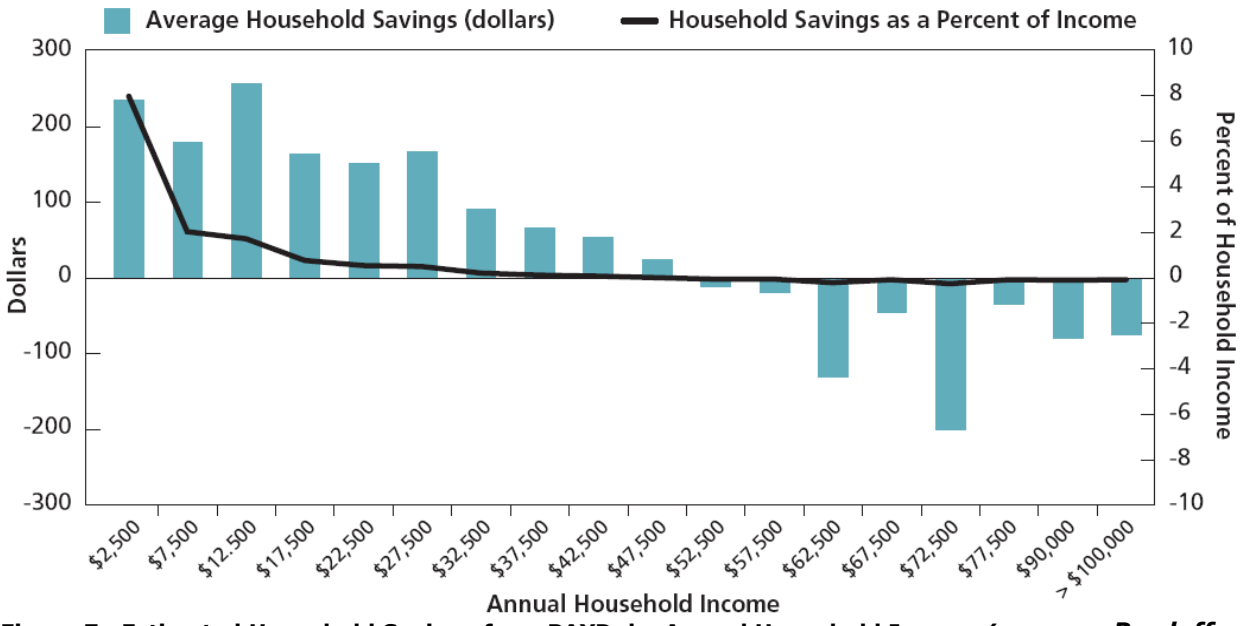


Figure 7. Estimated Household Savings from PAYD, by Annual Household Income (*source: Bordoff and Noel)*

Experience in other states: PAYD does not exist as a mandatory system anywhere in the U. S., but several insurance companies have pilot programs, including Progressive Insurance and GMAC. Pilots are also taking place in the United Kingdom. Several states are attempting to encourage PAYD, including Texas, California, and Oregon. The Federal Highway Administration is making available about $10 million for PAYD pilots in the next fiscal year. Fourteen states have PAYD in their climate action plans. Maryland forecasts that PAYD has the potential to reduce GHG emissions there by 1 million tons in 2015 and 4.3 million tons in 2020.[53]

Legal authority: The state's Division of Insurance has authority over auto insurance rates. At present the Division can allow companies to offer PAYD but cannot require them to do so. Legislation would be needed to require companies to provide PAYD as an option, or to require them to put all policies on a per mile basis.

Implementation issues: If the state does not require insurance companies to offer PAYD, insurance companies are unlikely to do so, as has been the case in other states. If the policy is optional for drivers, only a fraction may choose it, greatly reducing the impacts on GHG emissions and savings for drivers. Monitoring VMT through annual inspections carries the risk of errors, and will significantly reduce the incentive mechanism, by giving drivers feedback only once per year. Use of a telematic device that can be used to bill drivers monthly for their insurance would be more effective in influencing driver behavior. Information on costs could also be provided on a real-time basis through an on-board device or through a web site look-up. Some drivers might have privacy concerns about their driving being monitored telematically, even if the information is limited to VMT. In addition, the Brookings study argues that the cost of the telematic devices exceeds the benefits to the companies, so that incentives may be needed in order to achieve the social benefits of lower pollution, accidents, and congestion.

Uncertainty: Projections of the impact of PAYD on driving may not be correct, with actual VMT reductions lower than expected. In addition, administrative costs could be higher than expected.

[53] Center for Climate Strategies, www.climatestrategies.us/, 11/12/10.

Existing Policy

SUSTAINABLE DEVELOPMENT PRINCIPLES

Policy summary: In 2007, the Patrick-Murray Administration updated the Massachusetts *Sustainable Development Principles* to guide creation and implementation of state agency policies and programs, as well as investments in land and infrastructure. Municipalities, through policies like Commonwealth Capital, are also encouraged to modify their planning, regulatory, and funding actions to achieve consistency with the principles. The principles include promoting clean energy, in the form of energy efficiency and renewable power generation, in order to reduce GHG emissions and consumption of fossil fuels. They also encourage reductions in vehicle miles traveled (VMT) through actions such as the creation of "pedestrian-friendly" districts and neighborhoods that mix commercial, civic, cultural, educational, and recreational activities with parks and homes. In regard to housing, the principles call for building homes "near jobs, transit, and available services."

State investments, particularly those in infrastructure, have an important influence on where and how growth occurs. The principles are intended to guide policies, programs, and expenditures, particularly those that affect where and how development occurs. Making state investments consistent with the principles increases the amount of growth that takes place in locations and densities that reduce VMT and GHG emissions and have other clean energy benefits.

Economy-wide GHG emissions reduced in 2020 (in conjunction with Commonwealth Capital and MEPA)	0.1 million metric tons; 0.1%

Clean energy economy impacts: *Sustainable Development Principle* #9 — Promote Clean Energy — explicitly encourages clean energy practices, aiding development of clean energy jobs and reduced energy costs. Also, *Sustainable Development Principle* #1 — Concentrate Development and Mix Use, along with *Sustainable Development Principle* #7 — Provide Transportation Choice, can enable significant transportation cost reductions for residents and business due to reduced vehicle ownership and fuel consumption. Finally, Principle #1 will help to increase building efficiency and make district energy and combined heat and power more feasible.

Rationale: The principles provide a value statement and basic guide that state and municipal employees, business interests, land owners, developers, conservation groups, and others can turn to when making choices about their actions and investments. State policies, such as Commonwealth Capital, have the principles as their foundation. These policies expand upon the principles and provide an incentive to implement them.

Policy design: Readily implemented, since legislation is not required and regulatory changes would be minimal. However, improving the consistency of a large number of programs with the principles will require Executive leadership, perseverance, and a willingness to overcome obstacles.

One example of a state program that has utilized the *Sustainable Development Principles* is the Commonwealth Capital Program. More than $600 million in grants and low interest loans are awarded annually based in part on Commonwealth Capital scoring. Municipal smart growth/smart energy consistency is assessed through a Commonwealth Capital application. Resulting scores are

part of the proposal evaluation process for each grant or loan program. The more smart growth/smart energy oriented a community is, the more likely it is to receive funding. Since 2005, 315 out of 351 of the Commonwealth's communities have applied at least once and hundreds of new plans and regulations have improved municipal consistency with the *Sustainable Development Principles* by 10 percent (the median score has risen from 63 to 76 out of a possible 140).[54]

GHG impact: Existing smart growth policies, including the *Sustainable Development Principles*, are estimated to reduce GHG emissions by 0.1 percent in 2020. Recent studies[3] have shown integrated land use strategies can produce GHG reductions of between 2.7 percent and 4.4 percent from the baseline by 2050 depending on how aggressively the Commonwealth implements smart growth policies and practices.

Other benefits: Development consistent with the principles would lower operational and capital costs to government and society, improve energy conservation, better protect natural resources, increase housing and transportation choice, lower housing and transportation costs, improve public health, and enhance social and environmental justice.

Costs: There are predicted to be no incremental costs, as this policy simply requires more consistent decision making, particularly regarding the investment of current state resources in growth inducing infrastructure.

Equity issues: Smart growth increases affordability by reducing housing and transportation costs. It enhances access to jobs and services for those who can't/don't drive and provides a higher percentage of new jobs in urban areas where unemployment tends to be highest. Those who want to build commercial/industrial projects or live in homes in places and patterns that are inconsistent with the principles may pay more as these projects will no longer receive a state subsidy.

Experience in other states: Many states have successfully used sustainable development or smart growth principles to guide policies, programs, and investments.

Legal authority: The principles are presently implemented through an Executive Order. See Smart Growth Package for possible expanded scope of funding subject to principles and codification in legislation.

Implementation issues: Consistency of state policies, programs, and expenditures with the principles is not universal, and consistency is not always a prominent consideration in the decision making process.

Uncertainty: Calculating VMT and GHG benefits requires assumptions about how state policies, programs, and particularly spending will change to conform to the principles, as well as how dependent upon, or influenced by, state investments development is. Also, it is hard to predict how communities and developers will respond to incentives and other policies that encourage them to embrace the *Sustainable Development Principles*.

[54] See www.mass.gov/commcap for more information, including detailed analyses of past results and the 2011 application.

New Policy

GREENDOT

Policy summary: GreenDOT is the Massachusetts Department of Transportation's sustainability initiative, announced through a Policy Directive in June 2010 by the Secretary of Transportation. The Commonwealth's consultants, Cambridge Systematics, Inc., estimated that, if fully implemented, GreenDOT could achieve 2.1 million tons of GHG reductions in 2020 and the Secretary's Directive adopts this level as its target.

GreenDOT is intended to fulfill the requirements of several state laws, regulations, Executive Orders, and MassDOT policies, including the Global Warming Solutions Act, the Green Communities Act, the Healthy Transportation Compact, and the "Leading by Example" Executive Order Number 484 by Governor Patrick. MassDOT will work closely with DEP and the Advisory Group in determining the best regulatory and guidance framework for achieving the goals set forth in the Policy. GreenDOT is focused on three related goals: reduce GHG emissions; promote the healthy transportation modes of walking, bicycling, and public transit; and support for smart growth development.

GreenDOT encompasses a number of different program areas, which are described briefly below: statewide and regional long-range transportation planning, transportation project prioritization and selection, "complete streets" design guidelines, rail transportation, bicycle and pedestrian transportation, promotion of eco-driving, sustainable design and construction, system operations, facilities management, and travel demand management.

Transportation long-range planning and project prioritization and selection: Long-range planning documents, including statewide planning documents (e.g. the Strategic Plan, State Freight Plan, and MassDOT Capital Investment Plan), as well as the long-range Regional Transportation Plans from the Metropolitan Planning Organizations (MPO), must address MassDOT's three sustainability goals and plan for reducing GHG emissions over time. Similarly, the shorter-range regional and state Transportation Improvement Programs (TIPs and STIP), under which particular projects are chosen for funding in the coming four years, must be consistent with the Commonwealth's GHG reduction target. This will require that the MPOs and MassDOT balance highway system expansion projects with other projects that support smart growth development and promote public transit, walking and bicycling. In addition, the project programming mix included in the RTPs, TIPs and STIP can contribute to GHG reduction through prioritizing roadway projects that enable improved system operational efficiency, without expanding overall roadway system capacity.

Over the long term, both long-range planning and project selection will affect where new development in the Commonwealth is located and how that development is spatially configured. These choices affect the degree to which future development represents "smart growth," or clustered development patterns that facilitate walking, bicycling, riding public transit and driving shorter distances, which would minimize the number of motor vehicle miles that people must travel in order to go about their lives.

Project design and construction: The MassDOT Highway Division Project Development and Design Guide requires that all projects must adhere to a "complete streets" design approach, meaning that new and redesigned roads must provide appropriate accommodation for all users,

including pedestrians, bicyclists, and public transit riders. These modes of transportation will also be promoted by several other means. These include taking steps to see that more projects move forward through the Transportation Enhancements Program, extending the Bay State Greenway, improving accommodations for bicycles and pedestrians on bridges, and improving bicycle parking facilities at MBTA stations.

Several efforts will continue to improve rail transportation in the state. The MBTA is striving to both improve service on existing subway and commuter rail lines and to develop new service, such as the Green Line Extension and the South Coast Rail Project. Other projects will improve long-distance rail service for both passengers and freight.

MassDOT project design and construction will also reduce GHG impacts through such measures as the use of recycled content in paving materials, use of warm mix asphalt paving, implementation of stormwater remediation and use of best management practices, requirements for diesel engine retrofits for construction contractor vehicles, and other measures.

Travel demand management and travel information: MassDOT will continue to promote and deliver travel demand management (TDM) information and services, including ride-matching, traveler information, real-time bus tracking, and other measures for the general public and among MassDOT employees. MassDOT is currently working to implement a new ride-matching/trip planning system to facilitate carpooling, vanpooling, and mode shifting from automobile travel.

Eco-driving: Fuel efficiency can be improved greatly by maintaining vehicles properly, driving within the speed limit, and accelerating more gently. The EPA estimates that "smart driving" can improve fuel efficiency by up to 33 percent, and EcoDriving USA estimates that Massachusetts' drivers, with 5.4 million registered autos, could save about 4 million tons of CO_2 emissions annually if eco-driving practices were followed. MassDOT will promote eco-driving through: internal education for staff and contractors; external education of all Commonwealth drivers through website content, RMV manual and testing content, signage, and brochures; and development of a plan to improve tire inflation infrastructure.

System Operations: MassDOT, along with the MBTA and other regional transit authorities, will take a variety of steps to minimize fuel use and GHG emissions from vehicles and facilities. This includes retrofitting diesel buses with emission control devices, truck stop electrification, using solar and wind power at MassDOT facilities and rights-of-way, improving energy efficiency in MassDOT facilities, and increasing the share of low-emission transit vehicles in the MBTA fleet.

MassDOT will also facilitate more efficient roadway system operations; improvements that can reduce GHG emissions by reducing congestion and time spent idling in traffic. MassDOT will do this through the effective management of roadway capacity, using intelligent transportation systems - which may include such measures as real-time traveler information and management of traffic flow through improved traffic signal operations - ramp metering, and variable speed limits. MassDOT will also continue to address roadway system "bottlenecks," or points of localized capacity constraints, improvements that can reduce GHG emissions when traffic flow is improved without expanding overall system capacity.

Expanded Policy

SMART GROWTH POLICY PACKAGE

Policy summary: Development patterns significantly influence vehicle miles traveled (VMT), which could be substantially reduced by additional "smart growth" that makes it easier for households and businesses to decrease the number and distance of vehicle trips. Diffuse single use development accessed by car results in 30 percent[55] more VMT than compact mixed-use growth. Massachusetts already has several policies promoting smart growth, but new, complementary policies are necessary to achieve our smart growth targets. Such policies would focus on influencing infrastructure investments by state agencies and planning decisions made by local governments.

Economy-wide GHG emissions reduced in 2020	0.4 million metric tons; 0.4%
Motor fuel cost savings in 2020	$190 million
Jobs gained in 2020 (direct and indirect)	1,100 jobs

Clean energy economy impacts: Large transportation cost reductions can be expected for residents and business due to reduced vehicle ownership and fuel consumption. High density mixed-used development will increase building efficiency and make district energy and combined heat and power more feasible.

Rationale: Development of forests and open spaces increases GHG emissions in two ways: lost sequestration capacity and released carbon that had been stored in standing trees, and increased VMT due to sprawl. The Patrick-Murray Administration's historic commitment to land conservation has permanently protected over 72,000 acres from development, preserving one of our most valuable carbon sinks, and this initiative will continue into the future. Meanwhile, better land use patterns will be important for reducing or eliminating projected VMT increases and realizing GHG reductions from the transportation sector, which is expected to account for close to 40 percent of total GHG emissions in Massachusetts in 2020, with light vehicles (cars, SUVs, minivans, pickups) accounting for about 28 percent of the total. The Plan assumes that aggressive implementation of current land use policies can result in a 0.4 million metric tons of GHG reduction in 2020, based on getting 80 percent of new residential development to occur in mixed-use areas that are bike and pedestrian friendly and higher than typical density. Strict adherence to and continued enhancement of current policies, along with the implementation of new policies and programs will be necessary to realize the 2020 and 2050 GHG targets.

Design issues: Existing state policies include (a) GreenDOT — which prioritizes transportation projects that preserve the existing system, support denser "smart growth" development, and promote increased ridership, walking, and biking; (b) the MassWorks Infrastructure Program, that provides a one-stop shop for infrastructure funds via six separate programs, and promotes consistency with other state initiatives such as smart growth, Chapter 40R, and the 43D Expedited Permitting Program; and (c) the South Coast Rail Executive Order, which supports the South Coast Rail Economic Development and Land Use Plan by ensuring that agencies review

[55] See: Growing Cooler: The Evidence on Urban Development and Climate Change.

their policies, actions and investments to support and implement plan recommendations including priority development and preservation areas. Complementary policies are needed in order to achieve the 80 percent smart growth target. These are:

1. Reform state planning, subdivision, and zoning statutes — Pass the Land Use Partnership Act or similar legislation that provides municipalities a better framework for planning and zoning, enhanced tools to plan for and manage growth, and incentive to reduce VMT and GHG emissions through better development.
2. Provide technical assistance and undertake a smart growth promotional campaign — Expand efforts to help establish zoning and other land use regulations that reduce VMT. Provide direct technical assistance by state employees, tools such as model zoning, and grants to hire professional assistance. Also, use public appearances, the media, etc., to promote smart growth by pointing out its many benefits.
3. Require state infrastructure spending to include smart growth development in the criteria for funding decisions — State investments, particularly those in infrastructure and buildings, influence where and how growth occurs. Enhanced use of these investments to promote mixed-use, high-density development is critical to attainment of targeted VMT reductions resulting from better land use. This could be accomplished either via Executive Order or through legislation that codifies the *Sustainable Development Principles* and requires all agencies permitting, building, or funding infrastructure projects to take into account a set of smart growth criteria.
4. Significantly increase incentives to municipalities to plan and zone for development that reduces VMT — Much as the Green Communities Program has succeeded in persuading many communities to adopt desired practices - including the Stretch Code - strengthening existing incentives and offering new ones can persuade communities to use their regulatory authority in ways that reduce VMT. Enhance existing incentives such as Chapter 40R, Commonwealth Capital, and the Growth District Initiative, and implement new ones such as "Municipal Challenge Grants" that recognize the GHG benefits of development practices that preserve forest cover. Grants could be awarded to communities that institute an open space zoning bylaw that protects 50 percent of a parcel as forest, limits lot clearance to one-third acre per house, and requires best management practices for lot layout and tree preservation.

GHG impact: Existing policies will reduce GHG emissions by 0.23 percent in 2020[56] and recommended enhancements will realize additional reductions. Recent studies[57] have shown integrated land use strategies can produce GHG reductions of between 2.7 percent and 4.4 percent from the baseline by 2050, depending on how aggressively the Commonwealth implements smart growth policies and practices.

Equity issues: Smart growth increases affordability by reducing the amount households spend on both housing and transportation. It further reduces housing costs by increasing the variety of housing types available and decreasing the amount of land and infrastructure needed per housing unit, and enhances access to jobs and services for the young and infirmed, as well as those without a car. Finally, smart growth provides a higher percentage of new jobs in urban areas where unemployment tends to be highest.

[56] See: Eastern Research Group: Final Report to the Climate Protection and Green Economy Advisory Committee.

[57] See: Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions

Other benefits: Smart growth is as much as 70 percent cheaper for governments than the same amount of sprawl. It simply costs less to provide infrastructure (streets, schools, sewers, etc.) and services (like police and fire protection) to denser, more contiguous households than to far-flung, low-density communities.[58] Studies found that New Jersey and Rhode Island would save $1.3 and $1.5 billion, respectively, over 20 years.[59] It enhances public health by reducing air pollution and increasing physical activity, and enhances quality of life by improving neighborhoods, reducing travels times, and lowering costs. This, in turn, enhances economic competitiveness by appealing to prospective employees. Finally, it reduces development of open space, including forested land that sequesters carbon.

Costs: Existing and proposed smart growth policies have little cost as they rely almost entirely on enhanced use of existing funding. For example, state transportation funds should be shifted toward investments in support of desired development, without increasing the amount expended. Similarly, the financial incentives anticipate the use of existing state funding sources rather than creation of new ones. Modest additional funds are needed for technical assistance to municipalities and other entities to implement better zoning and other land use practices.

Experience in other states: Delaware, Maryland, New Jersey, New York, Rhode Island, and others have implemented smart growth programs that have improved growth patterns and thereby reduced VMT.

Legal authority: Legislation is needed to reform state planning, zoning and subdivision statutes and to codify and require agencies to implement the *Sustainable Development Principles*. The Commonwealth may also need to permit certain funding programs to implement municipal incentives and to authorize additional funding for incentives and technical assistance.

Implementation issues: It will be important achieve high levels of cooperation from all stakeholders, including development interests and local communities.

Uncertainty: Projected VMT and GHG reductions are taken from national level analyses and are not Massachusetts-specific. While state investments in infrastructure and buildings will help to steer growth to desirable locations and forms, developers can still finance their own projects and build in ways that result in excessive VMT. In addition, it is hard to project how many communities will take advantage of state incentives and whether growth will occur in these communities rather than others zoned for sprawl.

[58] http://www.brookings.edu/opinions/2003/0413metropolitanpolicy_katz.aspx?p=1

[59] See: Impact Assessment of the New Jersey State Development and Redevelopment Plan.

Non-Energy Emissions

Greenhouse gas emissions from activites not related to energy use represent a small but important part of statewide GHG emissions. Although these sources currently represent only 7 percent of total emissions, many of the gases emitted by these processes have a high global warming potential (GWP), thousands of times greater than CO_2. Furthermore, projections of future emissions, including the Commonwealth's 2020 BAU scenario, show steady growth in industrial emissions while emissions from most energy-related sectors — transportation excepted — are projected to level off or even decline.

Specific industrial processes that emit significant quantities of GHGs in Massachusetts include: leakage of refrigerant chemicals from commercial equipment and motor vehicle air conditioners, leakage of SF_6 from electric power transmission and distribution, and combustion of plastics in solid waste incinerators. The measures proposed in this section of the *Massachusetts Clean Energy and Climate Plan for 2020* address these sources of GHG emissions.

Reducing Leaks and Finding Substitutes for High GWP gases used in Refrigeration and Air Conditioning Units

The Montreal Protocol, which was designed to protect the ozone layer, has led to the substitution of ozone depleting substances with non-ozone depleters — hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) — in a range of applications including: insulating foams, refrigeration and air-conditioning, fire suppression, solvent cleaning, and propellants used in aerosols. Unfortunately, HFCs and PFCs are very potent GHGs. EPA has determined that the use of these chemicals comprises the most significant portion of non-energy related industrial emissions. This Plan will address emissions from the use of these chemicals in light duty motor vehicle air conditioning and commercial and industrial refrigeration.

For motor vehicle air conditioning, Massachusetts will adopt the California Air Resources Board (CARB) emissions standards for new motor vehicles (see Transportation). These standards will apply to model year 2017 vehicles and beyond, and include measures to both reduce leaks of high GWP gases and require use of lower GWP refrigerants. These measures are estimated to remove 0.27 $MMTCO_2e$ in 2020.

For refrigerants in stationary commercial and industrial equipment, the focus will be on reducing leaks from, and finding replacements for non-residential refrigeration equipment with units containing at least 50 pounds of refrigerant. It will build on EPA's voluntary program for grocery stores — in which many Massachusetts stores currently participate. CARB's November 2010 regulation phasing in leak detection and repair requirements will serve as a model for this program. The largest of these sources will report their emissions under Massachusetts GHG reporting rule and EPA's November 2010 mandatory reporting rule. The total impact estimated for this program is up to 1.18 $MMTCO_2e$ in 2020.

Reducing Leaks and Finding Substitutes for High GWP Gases Used in Electricity Distribution and Transmission

This policy will reduce emissions of sulfur hexafluoride (SF_6) gas from leakage where it is used to insulate switchgear in electricity transmission and distribution systems. It will build upon EPA's current voluntary program for SF_6 reduction and could ultimately include enforceable limits on leakage rates as well as best management practices. CARB has proposed a similar program. The impact of this policy is up to 0.15 $MMTCO_2e$ reduction by 2020.

Reducing Emissions from Disposal of Plastic Waste

Emissions associated with the combustion of plastics that remain in our solid waste streams can be minimized by greater diversion of plastics to recycling. Plastic recycling is already a priority in the Commonwealth and results in other environmental benefits, including the reduction of toxics in the environment and the growth of green jobs. This policy, implemented through the Massachusetts Solid Waste Master Plan, will aim to minimize the volume of plastic going to disposal in the Commonwealth, and instead divert these materials to recycling. Plastic diversion programs that include increasing assistance to cities and towns, increasing producer responsibility, and building markets for recycled materials are estimated to reduce GHG emissions by 0.3 $MMTCO_2e$ by 2020.

New Policy

REDUCING GHG EMISSIONS FROM MOTOR VEHICLE AIR CONDITIONING

Policy summary: The California Air Resources Board (CARB) is developing regulations to reduce emissions associated with motor vehicle air conditioning (MVAC).[60] Massachusetts General Law[61] mandates that the Massachusetts Department of Environmental Protection (MassDEP) adopt CARB's emission standards for new motor vehicles if they are more stringent than federal standards. CARB's standard aims to minimize emissions of high GWP refrigerants from MVAC through the adoption of standards for new light-duty vehicles. These standards include measures to reduce direct GHG emissions from MVAC systems, such as by using low GWP refrigerants and reducing leaks, as well as measures to reduce indirect emissions of other pollutants through improvement in the efficiency of the AC system (e.g., more efficient compressors, fans and motors; systems that avoid over-chilling and reheating; and technologies to reduce heat gain in the passenger cabin).

Annual benefits from improved motor vehicle air conditioning

Economy-wide GHG emissions reduced 2020	0.3 million metric tons CO_2e; 0.3%
Net cumulative $ savings statewide 2018-2020[62]	$50 - $130 million
Net annual $ savings per vehicle	$40 - $90

Clean energy economy impacts: Several of the measures aimed at reducing refrigerant leakage and making MVAC more efficient also have a positive impact on fuel economy and can be expected to reduce fuel costs for owners. Vehicle owners who pay less for fuel will have more money to spend on other purchases — producing a positive ripple effect on the economy as a whole, including the creation of in-state jobs. Reducing leakage may also reduce the frequency with which vehicles need to be serviced for refrigerant recharge.

Rationale: Transportation is expected to account for close to 40 percent of total GHG emissions in Massachusetts in 2020, and light vehicles by themselves (cars, SUVs, minivans, pickups) are around 28 percent of the total. MVAC emissions account for about 9 percent of GHG emissions from cars and light trucks. Air conditioning use is estimated to account for approximately 5.5 percent to 5.9 percent of vehicle fuel use in the US (although this figure is lower in Massachusetts).

Design issues: CARB is developing draft regulations. After the California rules are finalized and approved by EPA, MassDEP would adopt the CARB regulations if they are more stringent than federal standards.

GHG Impact: 0.27 million metric ton reduction in CO_2e in 2020. The policy applies to new vehicles starting with model year 2017. Since the policy addresses emissions from new motor vehicles, benefits will grow progressively as older vehicles are replaced in the active vehicle stock

[60] http://www.arb.ca.gov/cc/hfc-mac/mvac-gwp/mvac-gwp.htm

[61] http://www.malegislature.gov/Laws/GeneralLaws/PartI/TitleXVI/Chapter111/Section142K

[62] Derived from California cost estimates, given in year 2000 dollars.

(average of 10 years), with greater benefits after 2020 once the fleet has been fully replaced with compliant vehicles.

Other benefits: Between 2018 and 2020, the policy is estimated to save vehicle owners $50 million to $130 million statewide, or $40 to $90 per vehicle per year. In addition, there will be reductions in tailpipe emissions of non-GHG pollutants due to reduced fuel combustion, which will benefit public health.

Costs: Estimated annual per-vehicle costs and savings from MVAC policy (2000$).

Item	Values in 2020
Alternative refrigerant	$30 - $80
Improved system (leak tightness and efficiency)	$50
Gross incremental cost ($/year/vehicle)	$80 - $130
Annual fuel and refrigerant savings	$170
Net annual savings	$40 - $90

Equity issues: Incremental savings from the policy are expected to be distributed over all classes of vehicles. However, initially the higher upfront vehicle purchase costs will affect higher income drivers more, since lower income drivers tend to buy used cars. But lower income drivers will enjoy the savings only after compliant vehicles become available in the used car market.

Experience in other states: Fourteen jurisdictions use CARB's auto emission standards, including Maine, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Oregon, Washington, Arizona, Washington, D.C., and Bernalillo County, New Mexico.

Legal authority: Massachusetts General Law Chapter 111, Section 142K mandates that MassDEP adopt and implement CARB emission standards for new motor vehicles if such standards are more stringent than federal standards.

Implementation issues: Because light-duty vehicle efficiency standards for 2011 through 2020 (CAFE and California's vehicle GHG standards, both accounted for in existing policies) allow manufacturers to meet the standards partly through voluntarily reducing MVAC emissions, this policy discounted the benefits from MVAC emissions reductions. But manufacturers could choose to voluntarily implement even greater MVAC reductions under CAFE than assumed here, which would result in lower combined benefits of the efficiency and MVAC policies.

The policy calls for measures — in particular the switch to substitute refrigerants — that are still in development. While there are strong incentives to develop and refine the necessary technologies to meet existing requirements (e.g., EU regulations, other CA regulations), there is still a risk that estimated reductions may not be achievable.

Uncertainty: At least one study has highlighted the risk that more stringent emissions standards in selected states may reduce scrapping of used non-compliant cars and/or may result in car manufacturers achieving reductions in adopting states while potentially allowing for larger emissions and less efficient vehicles in other states. If so, these dynamics could reduce the effectiveness of the policy in achieving the projected emissions reductions in the short run.

New Policy

STATIONARY EQUIPMENT REFRIGERANT MANAGEMENT

Policy summary: This policy aims to minimize emissions of high Global Warming Potential refrigerants used in stationary non-residential equipment through:

- facility registration, leak detection and monitoring, leak repair, system retrofit and retirement, required service practices, and recordkeeping and reporting; and
- eventual replacement of non-residential refrigeration equipment at the end of its life by equipment using no-GWP or lower GWP substances, where such alternatives are available and practicable.

The policy would affect facilities with refrigeration units containing at least 50 pounds of refrigerant, beginning with a voluntary pilot program focused on leak detection and repair.

Economy-wide GHG emissions reduced 2020	1.2 million metric tons CO_2e; 1.3%
Net annual $ savings statewide	$1.6 million
Cumulative $ savings statewide 2012-2020, discounted[63]	$14 million

Clean energy economy impacts: Additional jobs in companies that engage in refrigeration system leak detection and repair. Cost savings to affected facilities from lower use of chemicals to refill systems.

Rationale: Common refrigerants include several types of hydrofluorocarbons (HFC). These chemicals have global warming potentials up to 12,000 times more potent than CO_2. Emissions from this source category have been growing steadily since the 1990s, in part due to the replacement with HFC of ozone depleting refrigerants targeted under the Montreal Protocol.

Design issues: California Air Resources Board (CARB) finalized a regulation[64] effective November 19, 2010, phasing in requirements for a leak detection and repair program for refrigeration units containing a charge of 50 pounds of refrigerant or greater. Massachusetts could implement a voluntary program that transitions into utilization of California's regulations as a model. Most of the businesses involved have been subject to similar EPA regulation on ozone-depleting chemicals used in refrigeration.

GHG impact: 1.2 million metric ton reduction in CO_2e in 2020.

Implementation issues: Implementing a program to reduce refrigerant emissions requires development of an inventory of facilities using large quantities of refrigerants. The number of facilities can be estimated from the Economic Census 2007,[65] a profile of U.S. businesses conducted every five years by the US Census Bureau. In addition, MassDEP will receive 2010 refrigerant emission data from large emitters by April 15, 2011, under the mandatory

[63] In 2008 dollars, discounted at a 5 percent rate from current year.

[64] http://www.arb.ca.gov/regact/2009/gwprmp09/gwprmp09.htm

[65] http://www.census.gov/econ/census07/, U.S. Census Bureau reporting 1,305 supermarkets and other groceries; 34 warehouse clubs and supercenters; 29 refrigerated warehousing and storage facilities; 523 cold product merchant wholesalers; and 153 cold manufacturing facilities in Massachusetts.

Massachusetts GHG emissions reporting program. MassDEP has already established relationships with larger supermarket store chains through efforts to encourage composting of food waste and reduce use of disposable shopping bags.

A number of Massachusetts grocery stores participate in EPA's voluntary "GreenChill Advanced Refrigeration Partnership,"[66] including Hannaford Bros., Price Chopper, Shaw's Supermarkets, and Whole Foods. In September 2009, a Star Market in Chestnut Hill became the first U.S. store certified at the Platinum level under EPA's GreenChill Store Certification program, while a Whole Foods store in Dedham received Silver certification in August 2009.[67]

On November 8, 2010, EPA signed final regulation 40 CFR 98 "Mandatory Reporting of Greenhouse Gases," Subpart L "Fluorinated Gas Production" and Subpart Q "Importers and Exporters of Fluorinated GHGs Inside Pre-charged Equipment or Closed-cell Foams,"[68] which require manufacturers and importers of substances including high GWP refrigerants to report GHG emissions, beginning with 2011 emissions reported by March 31, 2012.

Costs: Costs incurred by regulated entities pertaining to leak detection and repair can be divided into technology costs (equipment upgrades to automatic leak detection), operation and maintenance costs (leak detection, inspection, repair, annual program fee), and recordkeeping costs (data management and reporting). CARB's analysis of a similar policy indicates 2020 compliance costs ranging from $14 per facility with systems containing 50 to 200 pounds of refrigerant, $30 per facility with systems containing up to 2,000 pounds, and savings of $8,700 per facility with systems containing 2,000 pounds or more (net savings for larger facilities, due to economies of scale in reducing leakage).

CARB estimated savings of $2 per metric ton CO_2e in the year 2020 after the proposed regulation is fully implemented. This estimate may understate the actual net savings, since it does not account for rising refrigerant prices, energy savings due to optimized system operation, or benefits from mitigated climate impacts. Based on the number of facilities estimated to be affected by the policy (about 2,000) and an estimated distribution of the facilities by size, the policy is estimated to provide net savings of $1.6 million per year statewide.

Legal authority: MassDEP has authority to promulgate a regulation under Massachusetts General Law Chapter 111, Section 142 to create an enforceable refrigerants control program to prevent air pollution.

Uncertainty: Technical risks associated with leak detection and repair are expected to be relatively small. The practices promoted by the policy are already established. Implementation risks relate to the number and diversity of facilities that may be affected by the policy, which could complicate compliance assistance, verification, and enforcement. The effectiveness of the policy depends on facility owners actually implementing the practices called for in the policy, which may in turn depend on ensuring that technicians are trained and aware of the requirement.

[66] http://www.epa.gov/ozone/partnerships/greenchill/

[67] http://www.epa.gov/ozone/partnerships/greenchill/certcenter.html

[68] http://www.epa.gov/climatechange/emissions/subpart/dd.html

New Policy

REDUCING SF_6 EMISSIONS FROM GAS-INSULATED SWITCHGEAR

Policy summary: Through a pilot program, followed by possible regulatory action, this policy aims to minimize emissions of sulfur hexafluoride (SF_6) from leakage of gas insulated switchgear (GIS) used in electricity transmission and distribution systems by setting limits on leakage rates (declining to 1 percent leakage allowed in 2020) and implementing best management practices for the recovery and handling of SF_6.

Economy-wide GHG emissions reduced 2020	0.2 million metric tons CO_2e; 0.2%
Net cumulative $ costs statewide 2011-2020 (2008 $'s)[69]	$0.9 - $1.5 million

Clean energy economy impacts: There would be an expected increase in in-state employment for companies engaged in SF_6 leak detection and repair and potential for technological innovation, company formation, and jobs in solid-state (non-gas insulated) switch gear.

Rationale: SF_6 is a GHG that is 23,900 times more potent than CO_2 and has an atmospheric life of 3,200 years. One pound of SF_6 has the same global warming impact as 11 tons of CO_2. Approximately 80 percent of SF_6 consumption and emissions are estimated to result from the leakage and handling losses from GIS. Mitigation options for this equipment focus on reducing leakage and handling losses. Best practices include SF_6 leak detection and repair, and recovery and recycling.

Design issues: California Air Resources Board (CARB) has proposed a regulation[70] requiring GIS owners to reduce SF_6 emissions from electrical equipment throughout California 1 percent per year over a 10-year period. The initial allowed annual emission rate would be set at 10 percent of the total amount of SF6 that could leak; with the allowed annual rate declining to 1 percent in 2020. Massachusetts could use CARB's regulations as a model.

A number of Massachusetts utilities participate in EPA's voluntary "SF_6 Emission Reduction Partnership for Electric Power Systems,"[71] including: National Grid, NSTAR, and Western Massachusetts Electric Company. EPA does not publish any state- or utility-specific data from its voluntary program. On November 8, 2010, EPA signed final regulation 40 CFR 98 "Mandatory Reporting of Greenhouse Gases," Subpart DD "Use of electric transmission and distribution equipment,"[72] which requires reporting emissions from GIS, beginning with 2011 emissions reported by March 31, 2012.

As part of its development of a SF_6 emissions reduction program, CARB distributed a survey[73] requesting information from stakeholders on SF_6 emissions from the electricity sector "to

[69] In 2008 dollars, not discounted.

[70] http://www.arb.ca.gov/regact/2010/sf6elec/sf6elec.htm

[71] http://www.epa.gov/electricpower-sf6/

[72] http://www.epa.gov/climatechange/emissions/subpart/dd.html

[73] http://www.arb.ca.gov/cc/sf6elec/survey/sf6survey.doc

determine SF_6 GHG emission reduction potential and to assist ARB staff in developing appropriate control strategies." After consideration of any 2010 SF_6 emission data MassDEP receives by April 15, 2011 as part of the first mandatory Massachusetts SF_6 emission data reporting, MassDEP could consider whether a survey similar to CARB's would provide useful information for designing a regulation.

GHG impact: 0.15 million metric ton reduction in CO_2e in 2020.

Costs: According to CARB's analysis of a similar policy, the expense of compliance ranges from savings of $1/metric ton CO_2e (in the case of SF_6 recycling) to a cost of $55/metric ton CO_2e (in the case of GIS repair and replacement), depending on the measure necessary to meet the emission limits in any given year. Entities are assumed to use the cheapest methods first and progressively move to more expensive methods to achieve further reductions. Some entities may not incur a cost for reducing SF_6 emissions for some or all years to 2020, if their leak rates fall below a year's allowed limit. CARB estimates the cost effectiveness of the policy at about $18 per metric ton CO_2e reduced in the later years of the policy when the allowed leakage rate has declined to 1 percent. Similar cost effectiveness may be achieved in Massachusetts if the baseline practices and electric infrastructure profiles are comparable.

Equity issues: Full implementation of this policy may impose additional compliance costs on utilities, which could be passed on to customers — although that additional cost would be miniscule. CARB's analysis of the proposed regulation estimated the incremental cost that could be passed on to electricity ratepayers at $0.000016 to $0.000025 per kilowatt-hour as a result of the policy. This represents an increase of less than 0.02 percent relative to average residential electricity rates in Massachusetts, or about 1.5 cents for the average monthly residential electricity bill.

Legal authority: MassDEP would need to promulgate a regulation to create an enforceable SF_6 control program. MassDEP presently has the authority to regulate such air pollutants under Massachusetts General Law Chapter 111, Section 142; and it's authority over GHG emissions is amplified by the Global Warming Solutions Act.

Implementation issues and uncertainty: The policy promotes greater implementation of current industry best practices that are generally low-cost. The maximum emission rate set in California by CARB for the early years is already being achieved by Massachusetts utilities that have taken voluntary measures to reduce their emissions. Achieving the 1 percent limit in later years may require the use of relatively more expensive measures but these measures already exist.

Expanded Policy

REDUCING GHG EMISSIONS FROM PLASTICS

Policy summary: Solid waste is generated by residences and businesses across Massachusetts. Diverting high-carbon-content materials, such as plastics, from the waste stream can reduce emissions released after materials are discarded, and for some part of the waste stream, incinerated. These diverted materials can then be recycled into other products. Diverting plastics from the waste stream under this Plan will result in materials with a lower carbon content being combusted at Massachusetts municipal waste–to-energy facilities, reducing emissions of CO_2. Looking only at in-state emissions reductions, MassDEP conservatively estimates the reduction potential from diverting a portion of plastics from solid waste disposal in 2020 at 0.3 million metric tons of CO_2e per year.

Economy-wide GHG emissions reduced 2020	0.30 million metric tons CO_2e; 0.3%
Annual $ savings statewide in 2020	$8 to $11 million
Cumulative $ savings statewide 2009-2020[74]	$69 to $92 million

Clean energy economy impacts: Recycling yields greater local employment than does waste combustion. Currently, industries associated with recycling support 14,000 jobs in Massachusetts, and increased recycling of plastics would spur growth.

Rationale: The Commonwealth periodically prepares a *Solid Waste Master Plan* in accordance with Massachusetts General Law Chapter 16 Section 21. The solid waste sector includes sources of GHG emissions, such as landfills and municipal waste combustors, and plastics constitute a significant portion of the emissions. As detailed in a press release[75] that accompanied release of the most recent *Draft Solid Waste Master Plan*, "…The main objectives of the draft master plan include maximizing recycling, improving the environmental performance of solid waste facilities and developing integrated solid waste management systems. The draft master plan calls for a dramatic increase in residential, business and institutional recycling and composting, with an emphasis on paper and organics recycling…".

GHG impact: 0.3 million metric ton reduction in CO_2e in 2020.

Costs: According to the *Draft Solid Waste Master Plan*: "Diverting material from disposal, whether through upfront waste reduction, reuse, recycling or composting, can save significant disposal costs. Current disposal fees in Massachusetts typically range from $60 to $80 per ton. If we are able to achieve our goal of reducing disposal by 2 million tons per year by 2020, that would result in annual avoided disposal costs of $120-$160 million. Plastics diversion alone constitutes some $8 million to $11 million of the total $120 million to $160 million in annual avoided disposal costs.

Implementation issues: Public hearings have been held on the Commonwealth's *Draft 2010-2020 Solid Waste Master Plan: A Pathway to Zero Waste*.[76] All public comments have been received and are being reviewed.

[74] Based only on reduced disposal costs.

[75] http://www.mass.gov/dep/public/press/0710swmp.htm

[76] http://www.mass.gov/dep/recycle/priorities/dswmpu01.htm#swmp

Cross-cutting Policies

Introduction

Several policies do not fit neatly into the categories of buildings, electricity supply, transportation or non-energy emissions. These are state actions that drive clean energy adoption across all of these domains.

The Massachusetts Environmental Policy Act (MEPA) Office, which conducts the environmental review process for all large development projects, requires proponents to assess the environmental impact of a project and analyze alternatives in an effort to avoid, minimize and mitigate damage. This necessarily includes the buildings, energy supply, and transportation impacts of a project. The state's Leading By Example program, established by Governor Patrick, requires state agencies to reduce energy costs and lower emissions in state buildings, in vehicle fleets, and through green procurement. The Green Communities Division of DOER works closely with municipalities to help cities and towns lower their energy costs and adopt energy efficient technologies, add renewables to their energy mix, and make their fleets more fuel efficient. Though not, for the purposes of the *Massachusetts Clean Energy and Climate Plan for 2020*, discrete policies with their own measurable impacts on GHG emissions, they contribute to (and their impacts are accounted for within) numerous other initiatives contained in this Plan.

Finally, the Global Warming Solutions Act itself requires all state agencies, departments, boards, commissions and authorities to consider climate change impacts, such as GHG emissions, when they issue permits, licenses and other administrative approvals.

Expanded Policy

MEPA GHG Policy and Protocol

Policy summary: MEPA requires that all major projects proposed in the Commonwealth that have state involvement (in the form of state permits, land transfers or financial assistance, for example) undertake an assessment of project impacts and alternatives in an effort to avoid, minimize and mitigate damage to the environment to the maximum extent feasible. Building on this general requirement, the MEPA GHG Policy requires that certain projects undergoing review by the MEPA office quantify their GHG emissions and identify measures to avoid, minimize, and mitigate such emissions. In addition to quantifying project-related GHG emissions, the MEPA GHG Policy also requires proponents to evaluate project alternatives that may result in lower GHG emissions and to quantify the impact of proposed mitigation in terms of emissions and energy savings. The MEPA GHG Policy is primarily applied to commercial and residential real estate development projects, but also applies to industrial and energy generation projects.

Clean energy economy impacts: By requiring project proponents to evaluate all feasible measures to reduce their GHG emissions, such as energy efficiency upgrades, fuel switching, incorporation of renewable energy measures and reduction of vehicle miles traveled, the MEPA GHG Policy supports the development of industries and jobs to supply these technologies. In addition, the avoided fuel and electricity use due to enhanced efficiency of projects cuts the long-term operational costs of the projects.

Rationale: The principal purpose of the MEPA GHG Policy is to require project proponents to undertake a thorough analysis of a proposed project's primary sources of GHG emissions at an early stage of project planning and to examine all feasible alternatives that may have lower GHG emissions potential. By conducting this early-stage impacts and alternatives analysis, project proponents can integrate directly into project planning sustainable design considerations that will allow the project to achieve GHG emissions reductions in the most economical manner.

Policy design and issues: For the majority of projects subject to the MEPA GHG Policy, the Policy requires comparison of emissions associated with the proposed project design to the emissions that would result from construction of an identical building code-compliant project. In this way, the MEPA GHG Policy is closely related to issues surrounding the adoption of Advanced Building Energy Codes and other energy efficiency improvements for buildings. Similarly, where the MEPA GHG Policy encourages adoption of renewable energy components, it is closely related to issues involved in the implementation of incentives for generating renewable energy. The MEPA GHG Policy also aims to reduce vehicle miles traveled in coordination with other state policies.

GHG impact: To date, more than 90 projects have been at least partially reviewed in accordance with the MEPA GHG policy, and 32 projects have completed MEPA review with a finding that their GHG analysis adequately complied with the MEPA GHG Policy. Projects that have completed review have achieved an average reduction of 19.5 percent in stationary-source GHGs below an equivalent code-compliant project. Mobile source GHG reductions have ranged from zero to 25 percent, with an average of 5.8 percent. In total, the MEPA GHG Policy has resulted in commitments to reduce GHG emissions by over 70,000 tons per year to date. However, it is likely that a portion of these reductions, and many of the potential future reductions under the MEPA

Policy, may be duplicative of the reductions achieved by other state policies designed to increase efficiency, encourage renewable energy generation, and reduce vehicle miles traveled.

Costs: The upfront costs of incorporating GHG reduction measures will vary widely depending upon the project. Because the MEPA GHG Policy does not mandate a specified level of reductions, but rather asks project proponents to adopt "feasible" measures, measures that are considered infeasible from a cost perspective are eliminated from consideration.

Experience in other states: The MEPA GHG Policy is a nation-leading policy. Other states, including California and New York, have adopted similar policies, and the White House Council on Environmental Quality, which oversees implementation of the National Environmental Policy Act (NEPA) by federal agencies, has also released a draft policy concerning consideration of GHG emissions as part of the NEPA review of individual projects.

Legal authority: The Global Warming Solutions Act specifically amended the MEPA statute to provide that:

In considering and issuing permits, licenses and other administrative approvals and decisions, the respective agency, department, board, commission or authority shall also consider reasonably foreseeable climate change impacts, including additional GHG emissions, and effects, such as predicted sea level rise. See M.G.L. c. 30, §61.

Therefore, implementation of the MEPA GHG Policy is mandatory under the MEPA statute.

Implementation issues: The MEPA GHG Policy has become a routine part of the environmental impact review process. For real estate development projects, the assessment and review of a project's GHG analysis has become generally accepted by the regulated industry and the public.

Expanded Policy

LEADING BY EXAMPLE

Policy summary: The Leading by Example (LBE) Program, established in April 2007 by Governor Patrick's Executive Order (EO) No. 484, works to lower costs and reduce environmental impacts at all Executive Branch agencies, as well as the 29 public institutions of higher education and several quasi-public authorities. The program oversees efforts to reduce energy use at the state's 70 million square feet of buildings and fuel use among the thousands of light and heavy duty vehicles, expand recycling programs, reduce water consumption, promote environmentally preferable purchasing, facilitate the construction of high performance state buildings, and reduce carbon emissions across state government. EO 484 sets the following targets for state government: 25 percent reduction from a 2002 baseline in GHG emissions by 2012, 40 percent by 2020, and 80 percent by 2050; 20 percent reduction from a 2004 baseline in energy use intensity by 2012 and 35 percent by 2020; and an increase in consumption of renewable electricity to 15 percent of total electric use by 2012 and 30 percent by 2020. The EO also established a "Massachusetts LEED Plus" building standard for new construction and major renovation projects that requires all state government projects to achieve LEED certification and perform 20 percent better than the Massachusetts energy code.

The LBE Program is overseen by EEA and Administration and Finance, working collaboratively with state agencies such as the DOER (clean energy policies and project implementation), Division of Capital Asset Management (construction and energy projects) and Operational Services Division (procurement) to track state government energy use and GHG emissions, oversee the funding and implementation of dozens of clean energy projects annually, and provide technical assistance and training for dozens of agencies and hundreds of staff each year.

Despite the advances made by the LBE program, there is currently no single entity charged with managing and procuring low-cost, clean energy across all public agencies, authorities, and facilities. The Administration has proposed and will continue to work toward the development of a Common-wealth Energy Solutions program, which will end the separate decision-making by multiple agencies and provide an opportunity for a comprehensive, integrated strategy from procurement (taking advantage of economies of scale) to continuous monitoring and management of energy performance.

Clean energy economy impacts: Leading by Example efforts that include broad and comprehensive energy efficiency projects, as well as small and large-scale renewable project installations, will continue to create significant numbers of clean energy jobs in the construction and retrofit markets. Additionally, these efforts will result in a stabilization and potential reduction of state government energy costs, and will continue to reduce the amount of foreign oil used in public buildings.

Rationale: With approximately 70 million square feet of buildings, state government operations result in significant amounts of fuel consumption annually, including approximately 900 million kWh of electricity, 50 million therms of natural gas, 15 million gallons of fuel oil and more than million gallons of diesel fuel and gasoline. This consumption results in over 800,000 tons of GHG emissions and expenditures exceeding $220 million. Given this large impact, there is clearly a huge opportunity to reduce energy usage and associated carbon emissions. Such efforts will also demonstrate to other institutions and the private sector that large-scale energy reduction and renewable energy efforts are both feasible and fiscally desirable.

Design issues: Although significant clean energy programs are underway at state facilities, efforts to sustain such programs at the current scale once federal stimulus dollars are no longer present are needed. Also, efforts to streamline and simplify bidding and construction timelines have taken place, but more work will most likely be needed to ensure that projects are undertaken and completed in a timely fashion.

GHG impact: GHG emission impacts are directly related to energy reduction and renewable energy efforts at state facilities. If the 2012 targets in EO 484 are met, this would result in a reduction of approximately 200,000 metric tons of GHGs.

Other benefits: Additional benefits include reduced energy costs for Massachusetts taxpayers. The installation of new equipment also minimizes facility maintenance costs and needs, and improves comfort for the thousands of employees, residents, and visitors who work or live in, or visit, state facilities. LBE projects also provide important piloting for new technologies and system management initiatives that could be adopted by other institutions and cities and town, as well as the private sector.

Costs: Although exact costs are unknown, it is anticipated that over $200 million worth of clean energy projects will be implemented by 2012. Project costs will, for the most part, be funded through the Massachusetts Clean Energy Investment Program (CEIP), a newly developed program that is designed to provide low-rate bond financing paid for out of project savings. This program results in a positive cash flow early in the project and overall simple paybacks of between 10 and 20 years. Additional financing through 2012 and thereafter will be targeted through 3rd party financing, forward capacity market payments, Renewable Energy Credits, utility incentives, and, where available, renewable energy rebates.

Equity issues: There are no known equity issues.

Experience in other states: Many other states have undertaken "leading by example" efforts, including California, Colorado, Illinois, Indiana, New York, North California, Pennsylvania, and Utah. Success has varied, but all efforts recognize the impact to the state budget of reducing energy costs, as well as how such efforts are critical to the success of statewide clean energy goals, where applicable.

Legal authority: EO 484 provides the legal authority to those entities overseen by the Governor. Other independent entities, such as the MWRA, MassPort, and the Massachusetts Convention Center Authority, frequently participate on a voluntary basis in the LBE Program and undertake similar efforts, but they are not subject to the specific targets in the order.

Implementation issues: Successful implementation is dependent upon state resources, including financial and staffing. LBE staff will continue to work with key agencies, in particular the Division of Capital Asset Management and Executive Office for Administration and Finance, to ensure that such resources are available.

Uncertainty: Given the success of past efforts, current use of federal ARRA funding, and the ongoing collaboration between key agencies, it is likely that a significant number of clean energy projects will be initiated and completed over the next several years. However, meeting the energy and GHG emission reduction targets will depend on the extent to which energy reductions are sufficient to overcome new construction and expansion of services — particularly at the public institutions of higher education, which have seen a significant increase in enrollment and hours of operation. Additionally, ensuring that adequate funding exists to implement large-scale projects is critical to meeting the targets.

Existing Policy

GREEN COMMUNITIES DIVISION

Policy summary: Created by the Green Communities Act of 2008, the Green Communities Division of the DOER is intended to help municipalities become more sustainable, control rising energy costs, and incubate the clean energy technologies and practices that will put Massachusetts cities and towns — and the Commonwealth as a whole — at the center of the 21st century clean energy economy. Envisioned as a way to encourage municipalities to make greener energy decisions, the Division is mandated to offer grant and loan opportunities to municipalities in order to be designated as "Green Communities."

Clean energy economy impacts: The five required criteria to be designated a Green Community help municipal governments to reduce their own energy costs, and those of local residents and businesses; and help to achieve siting of wind, solar, and other renewable energy installations.

Rationale: Municipal governments are substantial consumers of fossil-fuel energy, primarily for buildings and secondarily from vehicles. The Energy Reduction Plan along with the Fuel Efficient Vehicle Policy required for designation as a Green Community results in municipalities reducing their energy consumption from municipal operations by a minimum of 20 percent. Through zoning they can have a major impact on the ability of renewable energy facilities to find suitable locations. And by deciding to adopt the "stretch" energy code (see Buildings) — another requirement for Green Communities designation — they significantly improve the energy efficiency of new construction and major renovations.

Policy design and issues: The Division provides technical assistance to communities to help them qualify for Green Community designation and state grants. To become Green Communities, municipalities must meet five criteria:

- Adopt a local zoning bylaw or ordinance that allows "as-of-right-siting" of renewable and/or alternative energy R&D facilities, manufacturing facilities or generation units;
- Adopt an expedited permitting process related to the as-of-right facilities;
- Establish a municipal energy use baseline and establishing a program designed to reduce use by 20 percent within five years;
- Purchase only fuel-efficient vehicles for municipal use, whenever such vehicles are commercially available and practicable; and
- Require all new residential construction over 3,000 square feet and all new commercial and industrial real estate construction to reduce lifecycle energy costs (such as adoption the Stretch Code).

The Green Communities Act allows funding of up to $10 million per year for the designation and grant program from the proceeds of Regional Greenhouse Gas Initiative (RGGI) allowance auctions and other sources. The Green Communities Division also serves all Massachusetts cities and towns as a one-stop shop for energy efficiency and renewable energy opportunities, helping them understand all the state programs at their disposal and providing streamlined delivery of those programs.

To achieve the goal of serving all 351 cities and towns in Massachusetts, the Green Communities Division offers a number of programs and services in addition to its signature Green Communities Grant Program. Other services include an energy assessment program in collaboration with the investor-owned utilities, technical assistance with energy savings performance contracting, stimulus grant programs and support, an online energy information system for tracking energy consumption and making decisions about how to reduce consumption, webinars and guidance documents and tools, a website and listserv for disseminating information and four Regional Coordinators to provide direct support to cities and towns.

GHG impact: GHG emissions are directly related to energy reduction and renewable energy efforts in municipalities. The first 35 Green Communities committed to reducing their energy consumption by 822,000 MMBTUs in five years. The newest 18 committed to a reduction of 592,000 MMBTUs over five years.

Other benefits: Additional benefits include reduced energy costs and a lower burden on Massachusetts taxpayers. Projects funded through the Green Communities Division can pilot new technologies and system management. In addition, the work done by municipalities to become designated as a Green Community requires buy-in of its residents, with meeting many of the criteria requiring a Town Meeting vote. This has resulted in a major grassroots movement to educate the larger citizenry on the benefits of reducing energy consumption and creating clean, renewable energy projects.

Costs: Up to $10 million per year, funded through the proceeds of Regional Greenhouse Gas Initiative (RGGI) emissions allowance auctions (see Electricity) and other sources.

Equity issues: There are no known equity issues. Grants are based on a $125,000 base for each designated Green Community, plus additional amounts tied to per capita income and population, and for municipalities that provide as-of-right siting for renewable energy generation. There are 53 designated communities from the Berkshires to Cape Cod, ranging in population from 990 to 621,000 residents.

Experience in other states: We are aware of no similar programs in other states. The Green Communities Division is believed to be the first of its kind in the nation.

Legal authority: The Green Communities Act of 2008 created the Division and the designation and grant program and authorized funding for it. The Board of Building Regulation and Standards approved the Stretch Code as an option for municipalities to adopt.

Implementation issues: As of December 2010, 53 communities had attained designation as Green Communities, thereby qualifying for funding from the Division. In addition, as of December 2010, 64 cities and towns had passed the Stretch Code.

Uncertainty: The Green Communities Division and Grant program are new and have created considerable excitement among Massachusetts cities and towns. It will be important in going forward to continue engaging municipalities in a manner that maintains that excitement. In addition, proceeds from the RGGI auctions, the main source of funding for the Division, are difficult to predict.

New Policy

CONSIDERATION OF GHG EMISSIONS IN STATE PERMITTING, LICENSING & ADMINISTRATIVE APPROVALS

Policy Summary and Rationale: Section 7 of the Global Warming Solutions Act states, "In considering and issuing permits, licenses and other administrative approvals and decisions, the respective agency, department, board, commission or authority shall also consider reasonably foreseeable climate change impacts, including additional GHG emissions..." in the context of environmental review. The body of landmark energy legislation that has been passed in the last four years established new expectations for how we manage energy, plan transportation, build our buildings, and generate and distribute electricity. The official approvals by state agencies, departments, boards, commissions and authorities often have implications for clean energy adoption and GHG emissions. EEA, in collaboration with other state and quasi-public agencies, will develop a plan to implement this requirement in selected agency actions.

III. Implementing the Global Warming Solutions Act

Setting the 2020 Limit

Section 4. (a) The secretary shall adopt the 2020 statewide GHG emissions…which shall be between 10 per cent and 25 per cent below the 1990 emissions level … (Global Warming Solutions Act of 2008; M.G.L. Chapter 21N)

Setting the statewide GHG emissions limit for 2020 was based on two years of analysis and public comment, and followed a process set forth in the Act.

In March 2009, the Executive Office of Energy and Environmental Affairs (EEA) established the Climate Protection and Green Economy Advisory Committee to provide input on the 2020 limit and measures to reduce GHG emissions in accordance with the Global Warming Solutions Act (GWSA). As required by the GWSA, the Advisory Committee included members representing the following sectors: commercial, industrial and manufacturing; transportation; low-income consumers; energy generation and distribution; environmental protection; energy efficiency and renewable energy; local government; and academic institutions. Advisory committee meetings were held throughout 2009 and 2010 and subcommittees were set up to examine technical aspects of possible policies.

In parallel and integrated with the activities of the Advisory Committee, EEA convened a technical working group consisting of staff from EEA, the Department of Environmental Protection (MassDEP), the DOER, the Department of Transportation (MassDOT), and the Executive Office of Housing and Economic Development (EOHED). This team spearheaded the technical analysis.

Overseen by this state agency technical working group, most of the analytical work was undertaken by a team of consultants, led by Eastern Research Group (ERG) and including several other firms with extensive expertise in specific sectors — Cambridge Systematics, Inc. on transportation, Synapse Energy Economics on electricity supply and energy use in buildings, and Abt Associates on the non-energy emissions sources. A variety of specialized models and data sources were used by the consultants for the various sector analyses. All the supporting data was then entered into the LEAP (long-range energy alternatives planning) model of Stockholm Environment Institute–U.S., another member of our consulting team. LEAP provides a convenient and sophisticated tool for integrating all the sectors and for running various policy scenarios. It was used both for the 2020 analysis and for development of hypothetical scenarios to reach the long-range 2050 reduction mandate. Finally, additional analysis of scenarios for shifting the motor vehicle fleet to lower-carbon alternatives to petroleum fuel was conducted by Ventana Associates, using system dynamics modeling.

The first step in the analysis was to determine what Massachusetts 1990 emissions level was and what the predicted "Business as Usual" (BAU) emissions trajectory to 2020 would be. MassDEP issued its *Statewide Greenhouse Gas Emissions Level: 1990 Baseline and 2020 BAU*

Projection[77] on July 1, 2009. The primary finding of this report was that, despite year-to-year variation, the trend line of GHG emissions has been relatively stable since 1990 and is predicted to remain relatively stable through 2020. Even though there has been robust economic growth in Massachusetts since 1990, GHG emissions have remained stable because the fuel mix in electricity generation shifted toward natural gas (which is less carbon-intensive than coal or oil), the Massachusetts economy shifted toward services, and the limited energy efficiency programs in place during that period moderated growth in energy use. The BAU estimate for 2020 is essentially a straight-line extrapolation of the 1990-2008 stable trend. This approach was chosen because the 1990-2008 period included both recessions and economic booms, and the underlying trends of that period are likely to continue, whereas attempts to create a more dynamic model of GHG trends in the future would unavoidably involve making a wide range of untested assumptions.

The next step in the analysis was to determine the expected GHG reductions by 2020 that would result from the policies and programs implemented or initiated since the beginning of the Patrick-Murray Administration, not including new policies that would be implemented under authority of the GWSA. In April 2010, Eastern Research Group submitted a report to the Advisory Committee, *Initial Estimates of Emissions Reductions from Existing Policies Related to Reducing Greenhouse Gas Emissions*. This report found that the energy efficiency, renewable energy, and transportation measures required by the Green Communities Act, the Advanced Biofuels Act, various state government executive actions, and the federal government would result in emissions being reduced to approximately 18 percent below 1990 levels by 2020 — roughly the midpoint of the 10 percent to 25 percent range required by the GWSA.

Following that report, EEA issued a Draft Climate Implementation Plan: A framework for meeting the 2020 and 2050 goals of the Global Warming Solutions Act. In the Implementation Plan, Secretary Bowles signaled his intention to set a 2020 emissions reduction requirement of 18 percent to 25 percent below 1990 levels and, for the final plan to achieve this limit, to give greatest consideration to those measures that show potential for significant energy cost savings and/or job creation.

In May 2010, Eastern Research Group submitted an additional report, *Cost-Effective Greenhouse Gas Mitigation in Massachusetts: An Analysis of 2020 Potential*. For this report, the consultants were asked to consider what additional GHG reductions would be technically feasible with cost-effective policies beyond those already in place. This report showed that it would be technically feasible to reduce emissions by up to 35 percent below 1990 levels by 2020 with additional policies that are cost-effective.

Both the draft implementation plan and the analysis of 2020 potential were used to focus a series of eight public hearings that were held in June 2010, as required by the Act. Nearly 200 individuals and organizations provided oral or written comment on the 2020 emissions reduction requirement and on policy measures to meet the requirement. The vast majority of commenters called for the Secretary to set the GHG limit at 25 percent below 1990 levels, the maximum allowed under the statute. A range of suggestions also pointed to a variety of

77 Statewide Greenhouse Gas Emissions Level: 1990 Baseline and 2020 Business As Usual Projection, Massachusetts Dept. of Environmental Protection, July 1, 2009.

different policy mechanisms that EEA should analyze in preparing the final implementation plan.

Following the hearings, EEA further consulted with the Climate Protection and Green Economy Advisory Committee and tasked the Advisory Committee's technical subcommittees, technical staff at EEA agencies, MassDOT, EOHED and other state agencies, and third-party consultants with analyzing a wide range of actions, policies, regulations, and legislation that could achieve additional clean energy gains and emissions reduction by 2020 and beyond. The Secretary then directed the technical teams to conduct in-depth analyses of those additional measures that satisfy criteria of cost-effectiveness while reducing GHG emissions. These in-depth analyses focused on GHG reduction potential; cost; clean energy economy impacts (cost of living, number and quality of jobs, reduced spending on fuel imports, etc.); implementation and design issues; experience in other states or jurisdictions; other co-benefits; equity issues; and uncertainties.

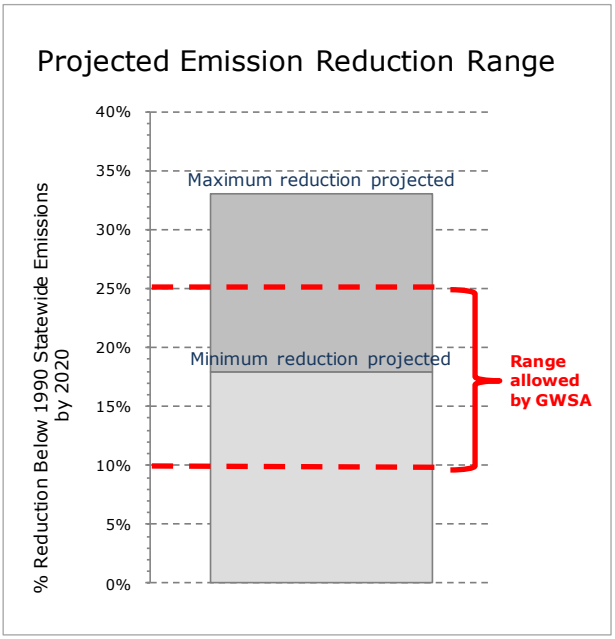


Figure 8. Projected emission reduction range below 1990 by 2020. The range results from uncertainties in Business as Usual (BAU) emissions, policy designs, and impacts of individual policies.

Table 2 (on page 91) displays the portfolio of policies incorporated in the *Massachusetts Clean Energy and Climate Plan for 2020*, and the associated potential contribution to GHG reduction below 1990 levels by 2020 for each policy. In aggregate, these policies, which include measures put in place since 2007 and new initiatives proposed in this Plan, are projected to achieve emissions reductions in the range of 18 percent to 33 percent by 2020 (see Figure 8). The lower end of this range represents a scenario in which Business as Usual (BAU) emissions are higher than projected and actual emission reductions from the policies as implemented are at the low end of estimates. The higher end of the range represents a scenario in which BAU emissions are lower than projected and implementation success is relatively high. A mid-range estimate for the portfolio of policies results in GHG emissions approximately 27 percent below 1990 levels by 2020.

Table 2. The Portfolio of Policies	**middle estimate % reduction below 1990**
Buildings	**9.8%**
All cost-effective energy efficiency/RGGI	7.1%
Advanced building energy codes	1.6%
Building energy rating and labeling	---
"Deep" energy efficiency improvements for buildings	0.2%
Expanding energy efficiency programs to C/I heating oil	0.1%
Developing a mature market for solar thermal water/space heating	0.1%
Tree retention and planting to reduce heating and cooling loads	0.1%
Federal appliance and product standards	0.6%
Electricity	**7.7%**
Expanded Renewable Portfolio Standard (RPS)	1.2%
More stringent EPA power plant rules	1.2%
Clean energy imports	5.4%
Clean energy performance standard (CPS)	---
Transportation	**7.6%**
Federal and California vehicle efficiency and GHG standards	2.6%
Federal emissions and fuel efficiency standards for medium and heavy-duty vehicles	0.3%
Federal renewable fuel standard and regional low carbon fuel standard	1.6%
Clean car consumer incentives	0.5%
Pay As You Drive (PAYD) auto insurance (pilot program, possible expansion later)	1.1%
Sustainable Development Principles	0.1%
GreenDOT	1.2%
Smart growth policy package	0.4%
Non-Energy Emissions	**2.0%**
Reducing GHG emissions from motor vehicle air conditioning	0.3%
Stationary equipment refrigerant management	1.3%
Reducing SF_6 emissions from gas-insulated switchgear	0.2%
Reducing GHG emissions from plastics	0.3%
Cross-cutting Policies	---
MEPA GHG policy and protocol	---
Leading by Example	---
Green Communities Division	---
Consideration of GHG emissions in State permitting, licensing and administrative approvals	---
Overall reductions versus 1990 (adjusted for uncertainty in Business as Usual (BAU) emissions, policy designs, and impacts of individual policies)	
High BAU emissions and low policy impacts	**18%**
Middle BAU emissions and policy impacts	**27%**
Low BAU emissions and high policy impacts	**33%**

Note: the overall reduction is adjusted for overlap among policies, so is smaller than the sum of the individual policies. Individual lines may not sum to subtotals due to rounding.

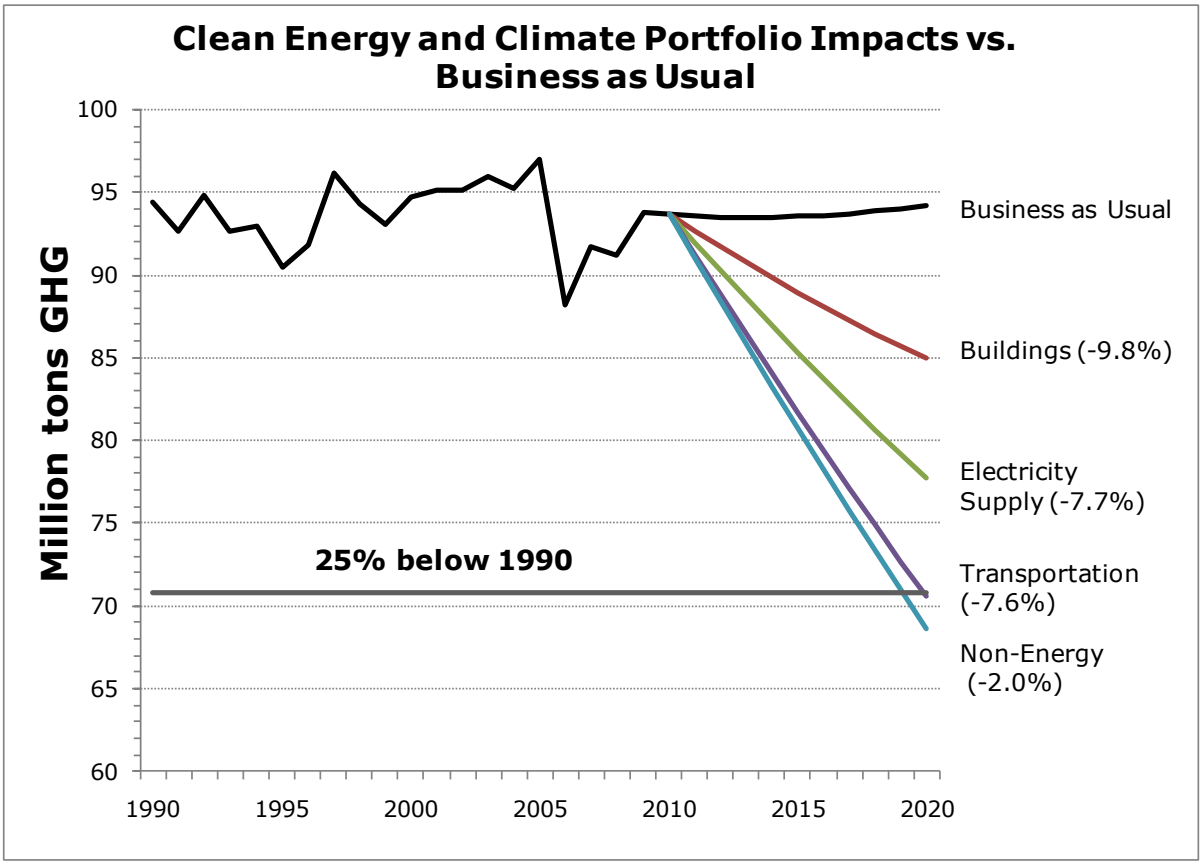


Figure 9. Emissions reductions by sector for the portfolio of policies, at the mid-range estimate of 27 percent below 1990 levels by 2020.

Based on these analyses, input from the Advisory Committee, and full consideration of the public comments received, EEA Secretary Ian Bowles determined that a responsible and achievable GHG emissions reduction limit for 2020 that maximizes opportunities to realize energy cost savings, increase energy independence, and promote growth in clean energy jobs in Massachusetts is 25 percent — the high end of the range for 2020 authorized by GWSA, but the middle of the range of possible outcomes for the policies incorporated in this Plan.

In setting this limit, the Secretary took into account the statutory mandate of 80 percent reduction by 2050, which led him to set the 2020 limit as high as is practical. He also did so based on his understanding that the portfolio of measures outlined in the Integrated Portfolio section of this Plan, discounted for uncertainty and potential implementation constraints, provides enough flexibility and redundancy for the Commonwealth to achieve the 2020 reduction limit of 25 percent.

Putting the Plan into Action

In 2011, state agencies responsible for each new measure will complete program development and consultative processes with stakeholders, in order to create an implementation plan for each policy outlined in this Plan. Given the portfolio nature of the policies included in the Plan, there will naturally be a diversity of processes to move each policy forward. For example, some require pilot programs (such as the Pay As You Drive pilot program that is dependent on Federal Highway funding). Others require expansion of existing programs (such as energy efficiency). Still others may require legislation even as administrative actions move them forward (such as the expansion of renewable energy credits from electricity to include thermal energy).

As part of continued policy development, more detailed cost and benefit information will be analyzed and used to design programs to maximize a cost-effective transition to an equitable clean energy future, which includes well-distributed green jobs and business growth, as well as GHG gas reduction.

In order to monitor progress in implementing the Plan, the Climate Protection and Green Economy Advisory Committee will remain in existence, and the Secretary of EEA will present an annual progress report to the Committee by December 31 of each year. In preparation for that annual report, all responsible agencies (EEA agencies, MassDOT, EOHED, and others) will report to the EEA Secretary by October 31 of each year on their progress toward implementation. The Secretary will, in turn, compile a complete report for the Climate Protection and Green Economy Advisory Committee. The first full progress review required by the Act will be in 2015.

Engaging Citizens to Realize our Clean Energy Future: Individuals, Cities & Towns, and Regional Planning Agencies

Throughout the development of this Plan, there has been ongoing interest on the part of the Advisory Committee and the public concerning the need for continued citizen engagement in reaching the clean energy and climate goals set forth in the Global Warming Solution Act.

During the course of eight public hearings held across the state and in written comments, EEA learned of many projects and activities that Massachusetts citizens, non-governmental organizations (NGOs), universities, business groups, and municipalities are engaged in to reduce GHG emissions and work toward a clean energy future. EEA and the Commonwealth's agencies recognize the value of these efforts and commit to work together and support them as we collectively strive to implement this Plan.

Individuals are already making clean energy decisions such as making their homes more energy efficient, and are eager for information about how they can do so where they work, shop and play.

As of December 2010, 53 communities had attained designation as Green Communities, becoming eligible for funding to go greener as a result; and 64 communities have adopted the "stretch code," a local-option building code that sets a standard of 20 percent to 30 percent more energy efficient than the Commonwealth's recently adopted statewide code. Earlier this year, the city of Boston adopted a wide-ranging climate action plan that was developed through extensive community engagement. In addition, a variety of independent climate and energy initiatives at the municipal level are developing practices and information that state agencies can learn from and support.

Regional planning organizations, in particular, are valuable partners for the state to work with in crafting solutions tailored to the unique challenges and opportunities of their regions. Some already have sustainability and/or smart growth programs that result in GHG reduction. For example, the Pioneer Valley Planning Commission and Franklin Regional Council of Governments recently released a clean energy plan that charts a path toward greater energy independence and the use of cleaner and more efficient energy in the Valley. The process of creating and now implementing the plan has been a prime example of state, regional and local government collaboration, and engagement of citizens, non-governmental organizations (NGOs) and the private sector.

NGOs of all types are making effective use of their community roots to raise consciousness about the risks of climate change and the opportunities for a clean energy future. College and university students are informed, organized and eager to help shape their energy and climate future; these students gave impassioned testimony at every public hearing.

As the Commonwealth agencies responsible for implementing parts of this Plan develop their programs, they will look for opportunities to work with and support these ongoing efforts. Most state agencies have a local presence and networks that can facilitate coordination with local groups; for example, MassDEP has four regional offices and DOER has a Green Communities coordinator located in each of them. MassDOT also has regional offices as well as established relationships with regional planning organizations and regional transit authorities. Pilots and demonstration projects conducted as agencies develop their respective programs under this Plan will provide excellent opportunities to involve local groups in state initiatives.

The work of individuals, municipalities, universities, business organizations, NGOs, and regional planning organizations will be essential to the Commonwealth's success in implementing this Plan and making the transition to a clean energy economy.

IV. Beyond 2020: The Road to 80 Percent Lower Emissions in 2050

Scenarios for a Clean Energy Future

The clean energy economy of 2050 will be very different than the fossil fuel dominated economy of today. With many of the policies embodied in this report in place, 2050 would find a Massachusetts where energy costs are less volatile and comprise a smaller part of budgets. Businesses, households, municipalities and institutions are better able to manage their energy needs. Renewable and alternative sources of energy have largely displaced fossil-based sources, and a smart grid and advanced technology store and release to the grid as needed the electricity generated during the night by massive wind farms off the coast of the Northeast. Both small and large-scale solar installations are ubiquitous across the state.

In this scenario, global geopolitics has dramatically changed also, and United States foreign policy is no longer influenced by the politics of petroleum, natural gas, and coal. National security has been strengthened by an economy driven by homegrown sources of energy that no longer depend on fossil fuel from unstable regions or from countries that do not share the interests of the U.S.

By 2050, the clean energy cluster in Massachusetts has matured, much as the biotechnology and health care sectors matured in the early part of the 21st century. Small entrepreneurial companies and multi-nationals, R&D, manufacturing and service companies make up a varied and dynamic clean energy economic landscape. Massachusetts plays a dominant role in the global market for technologies in offshore wind, solar PV and thermal, electricity storage and energy management. Massachusetts architects and engineers are leaders internationally in green building design and building energy management. Massachusetts companies that have pioneered battery technology have robust partnerships with American, European, Indian and Chinese car and truck manufacturers.

And, by 2050, GHG emissions will, by law, be 80 percent less than what they were in 1990, and the air will be cleaner.

Even as we chart the course through 2020, it is critical to plan for the path to 2050. Getting to this clean energy future will require significant innovation in policy, technology and business practices. Unlike the 2020 limit, which can be met with actions that we take here in Massachusetts, reaching 80 percent reductions below 1990 emission levels, as required by the Global Warming Solutions Act, will mean broad changes that are beyond the reach of Massachusetts alone. Between 2010 and 2050, much will change — in the economy, in federal regulation, and in technology — that will make possible GHG emission reductions that would be unthinkable today. With the nation-leading requirements of the GWSA, Massachusetts should — and must — stay ahead of the curve. But as it reaches for the more ambitious mandates of 2030, 2040, and 2050 required by the GWSA, Massachusetts can only build on changes percolating throughout the U.S. economy, not strike out entirely on its own.

But in imagining — and planning for — a path to the mandated GHG emissions reduction of 80 percent in 2050, it is important to ask now: How do we get there?

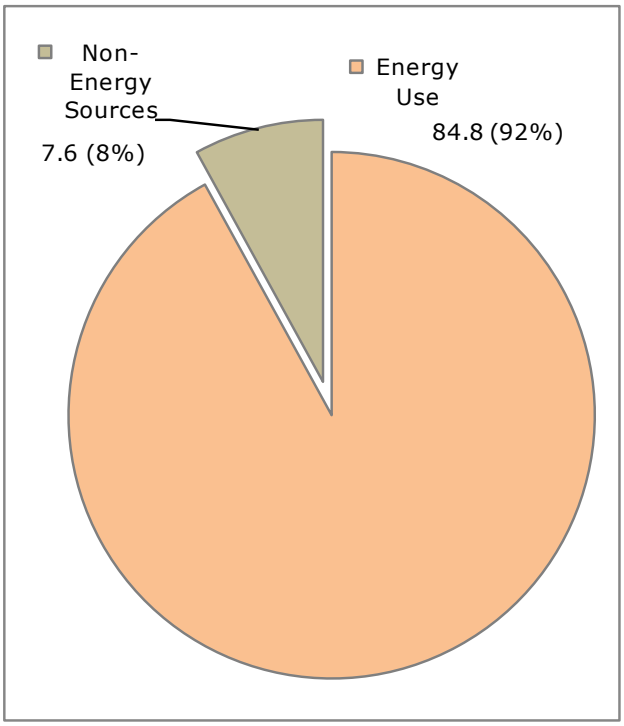


Figure 10. Massachusetts GHG Emissions in 2007 (MMTCO$_2$e and %)

It helps to consider the sources of GHG emissions in Massachusetts. As Figure 10 shows, the vast majority of our state's emissions come from energy use. Burning carbon intensive fuels for transportation, in buildings, and for electricity generation accounted for about 92 percent of statewide GHG emissions in 2007. The rest of the emissions — a scant 8 percent — were from activities other than fuel combustion, such as wastewater treatment and agriculture (both of which emit methane and other GHGs).

Broadly speaking, it is possible to lower GHG emissions from energy use in three ways:

Efficiency — Finding means to deliver the same services (e.g., miles traveled by passenger vehicles, indoor air temperature) using less energy. Examples include weatherizing buildings so they consume less energy to provide comfortable indoor spaces, and higher fuel efficiency standards for passenger vehicles and light trucks so that less fuel is combusted for every mile traveled.

Conservation — Making lifestyle choices that lower energy use even in the absence of efficiency improvements. An example is reducing non-essential driving.

Cleaner energy sources — Substituting low carbon energy sources for the carbon intensive fuels we use today. An example is generating electricity from wind or solar energy instead of from fossil fuels.

The first two of these approaches target energy demand, while the third focuses on energy supply.

This chapter explores how these approaches could be combined with cuts in non-energy emissions to hit the 2050 target required for Massachusetts. It presents the results of scenario modeling of the state's energy system and economy, conducted to assess conditions that would allow achievement of the 2050 limit. The first part characterizes the modeling process and explains how the two scenarios presented here were devised. A summary of the scenarios and their emissions and energy projections follows, along with implications for Massachusetts clean energy and climate policy. The chapter goes on to review policies which will either have small impacts by 2020 or may not be needed to reach the 2020 emissions limit, but are critical to achieving the 2050 limit.

Scenario Modeling: Purpose and Process

In order to understand the challenges and opportunities of meeting the 80 percent by 2050 goal, the EEA began by modeling scenarios of statewide energy use and GHG emissions. The scenarios comprised all modes of transportation, residential and commercial buildings, electricity generation, and numerous other factors.

Assisted by technical consultants, EEA used the scenarios to project potential futures for Massachusetts that would allow attainment of the 2050 goal. In this sense, the scenarios were not so much predictions or forecasts as thought experiments: they showed possible ways to cut GHG emissions under various conditions. A central consideration in crafting the scenarios was that they be plausible. To that end, the modeling team limited itself to technology that is currently available or expected to emerge shortly. The team also consulted published scientific and technical literature and other government and academic modeling projects for insights into plausibility.

After experimenting with several scenarios, the modeling team developed two that achieved the 80 percent target (within a reasonable margin of error): one stressing electrification and clean electricity supply; and another prioritizing efficiency and conservation measures. The next sections describe these scenarios. The team also determined that the target could be attainable in a scenario of substituting low carbon biofuels for fossil fuels. However, as such a scenario is basically equivalent to the electrification scenario — replacing clean electricity with clean biofuels — it is not treated here.

Scenario Descriptions: Narratives and Assumptions

SCENARIO 1 — ELECTRIFICATION: A RESIDENT'S VIEW

Houses are better insulated and ventilated than they were 40 years ago. Many houses look like those from the Massachusetts 2010 Zero Energy Challenge — there are a number in your neighborhood. Increasingly, homeowners are turning to electric heat pumps for space and water heating. The cost of these systems has been dropping for a number of years, and it's now standard practice to include them in new houses. Solar hot water and residential photovoltaic (PV) installations are also commonplace. You rented out your rooftop to a solar PV company last year, cutting your electricity bill in half.

You still drive to work each day, but you do it in a highly efficient electric car. When you take public transportation, you're generally in an electric vehicle as well — whether a train, bus, or subway. You hardly see any petroleum-powered vehicles anymore, except for airplanes and some trucks. But even those use a 40 percent biofuel blend.

Most commercial buildings are more energy efficient than they were in 2010; a significant fraction look like the advanced green buildings of that era. Just as in houses, electric heat pumps, solar hot water, and PV arrays are increasingly the norm in commercial buildings.

You work in an industrial setting — at a advanced battery manufacturer that supplies batteries for the new fleets of cars, minvans, and trucks that are coming out of Detroit — and business is booming. Gross state product has more than doubled since 2010, while industry's fraction of it is unchanged. Meanwhile, the energy intensity of industrial operations has been falling, and many firms have retooled their processes around electric power (instead of fossil fuels). Your employer recently replaced most of the equipment on the shop floor with new high-efficiency models, improving productivity and cutting operating expenses.

The electrification scenario meets the challenge of the 2050 goal by pairing widespread electrification in transportation, buildings, and industry (i.e., switching from fossil fuels to electricity) with an extremely clean electricity supply. These changes are backed up by energy efficiency gains throughout the economy and progress toward reducing non-energy GHG emissions. Table 3 lists the major assumptions defining the electrification scenario. The narrative in the sidebar describes what you might experience if you were a resident of Massachusetts in 2050.

Table 3. Electrification Scenario	
Sector	**Assumption**
Statewide	The population of Massachusetts grows to 7.6 million people by 2050 (about 18% higher than today).
	Gross state product (GSP) grows to $930 billion (2008$) by 2050 (approximately 150% higher than today). This increase is based on the historical rate of per capita income growth in Massachusetts.
Transportation	By 2050, 90% of light duty vehicles are pure electric, 5% are plug-in electric, and 5% are hybrids.
	By 2050, passenger and freight vehicle efficiency improves substantially. For example, holding vehicle size constant, the energy intensity of hybrid gasoline cars (energy required per mile traveled) falls about 31% between now and 2050.
	By 2050, transit service doubles and number of people per vehicle increases 20% from today's levels.
	By 2050, commuter rail and intercity rail in Massachusetts are completely electric; 90% of buses are electric.
	By 2050, 40% of commercial aircraft and road freight miles are powered by biofuel that produces 70% fewer GHG emissions than burning gasoline.
	Growth in annual commercial air travel miles stops in 2020.
Residential and Commercial Buildings	By 2050, only 16% of houses have the same energy use profile as a typical house today; 40% match the energy performance of today's advanced green houses. New and upgraded houses mainly use electric heat pumps for space and water heating.
	By 2050, only 20% of commercial buildings have the same energy use profile as a typical commercial building today; 40% match the energy performance of today's advanced green commercial buildings. New and upgraded buildings mainly use electric heat pumps for space and water heating.
Industry	Rising at the same rate as GSP, industrial output in Massachusetts grows to $162 billion (2008$) by 2050.
	40% of industrial energy comes from electricity in 2050.
	Between now and 2050, industrial energy intensity (energy required per $ of output) decreases 2% per year on average.
Electricity Generation	By 2050, 100% of the electricity consumed in Massachusetts comes from near zero carbon sources: renewables, pre-2000 nuclear facilities, and a small amount of biomass, and this constitutes 112% of what total Massachusetts electricity use was in 2007, or 9 times the amount of low-carbon supply in 2007. The state no longer uses any electricity from natural gas, coal, or oil.

Scenario Descriptions: Narratives and Assumptions

Scenario 2 — Efficiency and Conservation Scenario: A Resident's View

Every house in the state uses less energy per square foot than a typical house did 40 years ago. Improved lighting, insulation, appliances, and heating and cooling systems are universal. Houses remaining from 2010 have been equipped with these enhancements (to a greater or lesser degree), and new houses include them as a matter of course. Nearly half of all houses meet efficiency standards only attained by the best "green" prototypes in 2010. Yours is one of them: when you bought it 10 years ago, you had a deep energy improvement performed before moving in. The contractor installed an electric heat pump for heating and cooling, solar hot water collectors, and a PV array, among other improvements. Residents statewide are increasingly choosing these technologies to meet household energy needs. They're also opting for markedly smaller homes, prompting a reduction in the size of new houses and conversions of large dwellings into multi-family residences.

For several decades, the trend in passenger vehicles has been toward more efficient cars. Light trucks have fallen out of favor except with tradespeople who need them for work, as have SUVs except for those who need true off-road capability, with the number on the road dropping 75 percent since 2010. Drivers are carpooling more, and everyone thinks twice about single-purpose drives to the store or the mall. You still have that hybrid, but your spouse made the switch to an electric car a few years ago, and you take the electric when you travel together. More and more, you use public transportation when you can. It helps that transit service is more widespread and frequent than it used to be. You don't travel by plane as much as you once did, either; for short and middle distance trips, you go by high-speed train or your car, and you take long trips less often.

Like everyone you know, you work in a building that's substantially more energy efficient than commercial buildings were in 2010. Half of today's buildings would have been considered advanced green buildings in 2010, and many use electric heat pumps instead of fossil fuels.

Industrial output in Massachusetts has more than doubled since 2010, while the energy intensity of industrial production has fallen by almost two thirds. Enterprises requiring a skilled, educated workforce continue to locate in the state, contributing to steady economic growth.

The efficiency and conservation scenario achieves the 2050 goal through a combination of maximal efficiency gains in all sectors and consumer choices favoring energy efficiency and conservation. Complementing these developments are some fuel switching toward electricity, a significant (but not total) de-carbonization of the electricity supply, and cuts in non-energy emissions. Table 4 shows the principal assumptions underpinning the efficiency and conservation scenario, and the sidebar provides a parallel narrative — what you might experience under this scenario if you were a resident of Massachusetts in 2050.

Table 4. Efficiency and Conservation Scenario

Sector	Assumption
Statewide	The population of Massachusetts grows to 7.6 million people by 2050 (about 18% higher than today).
	Gross state product (GSP) grows to $930 billion (2008$) by 2050 (approximately 150% higher than today). This increase is based on the historical rate of per capita income growth in Massachusetts.
Transportation	By 2050, 60% of light duty vehicles are pure electric, 20% are plug-in electric, and 20% are hybrids.
	By 2050, passenger and freight vehicle efficiency improves even more than in scenario 1, with (for example) the energy intensity of hybrid gasoline cars falling about 36% between now and 2050.
	Consumer preferences shift toward more efficient cars. By 2050, technologies allow cars to use one third less energy than it otherwise would have.
	Apart from those who need special functions, consumers shift away from light trucks and passenger vehicles built on light truck chassis (SUVs). By 2050, the share of trucks in the light duty vehicle fleet drops to 10 percent (from around 40 percent today).
	By 2050, utilization of cars and light trucks rises to 2.0 people/vehicle (compared to 1.6 today).
	By 2050, less non-essential driving causes the total number of miles traveled in light duty vehicles to be 15% lower than it would otherwise have been.
	By 2050, transit service increases 2.5 times and ratio of people-per-vehicle rises 30% from today's levels.
	By 2050, 40% of commercial aircraft and road freight miles are powered by biofuel that produces 70% fewer GHG emissions than gasoline.
	Annual commercial air travel miles drop 50% between 2010 and 2050 as regional and intercity rail increases.
Residential and Commercial Buildings	By 2050, no houses have the energy use profile of a typical house today; 45% match the energy performance of today's advanced green houses. New and upgraded houses mainly use electric heat pumps for space and water heating.
	By 2050, only 5% of commercial buildings have the energy use profile of a typical commercial building today; 50% match the energy performance of today's advanced green commercial buildings. New and upgraded buildings mainly use electric heat pumps for space and water heating.
	In residential buildings, average square footage per household is about 22% lower in 2050 than today.
Industry	Rising at the same rate as GSP, industrial output in Massachusetts grows to $162 billion (2008$) by 2050.
	Between now and 2050, industrial energy intensity decreases 2.5% per year on average.
Electricity Generation	By 2050, about 80% of the electricity consumed in Massachusetts comes from near zero carbon sources: renewables, pre-2000 nuclear facilities, and a small amount of biomass used in high efficiency combined-heat-and-power applications. The low-carbon power is about five times the amount used in Massachusetts in 2007 (about half the amount of low-carbon power needed in the electrification scenario). The remainder is from natural gas generation.

Scenario Results

In both the electrification and efficiency and conservation scenarios, Massachusetts reaches the 80 percent target by 2050. Given the first two assumptions in Tables 1 and 2 — of rising population and real income — this achievement is remarkable.

Significant changes in infrastructure, technology, and consumer choices pave the way to the 80 percent reduction. Figure 11 depicts projected statewide GHG emissions under the scenarios, as well as historic emissions and a business-as-usual trajectory.

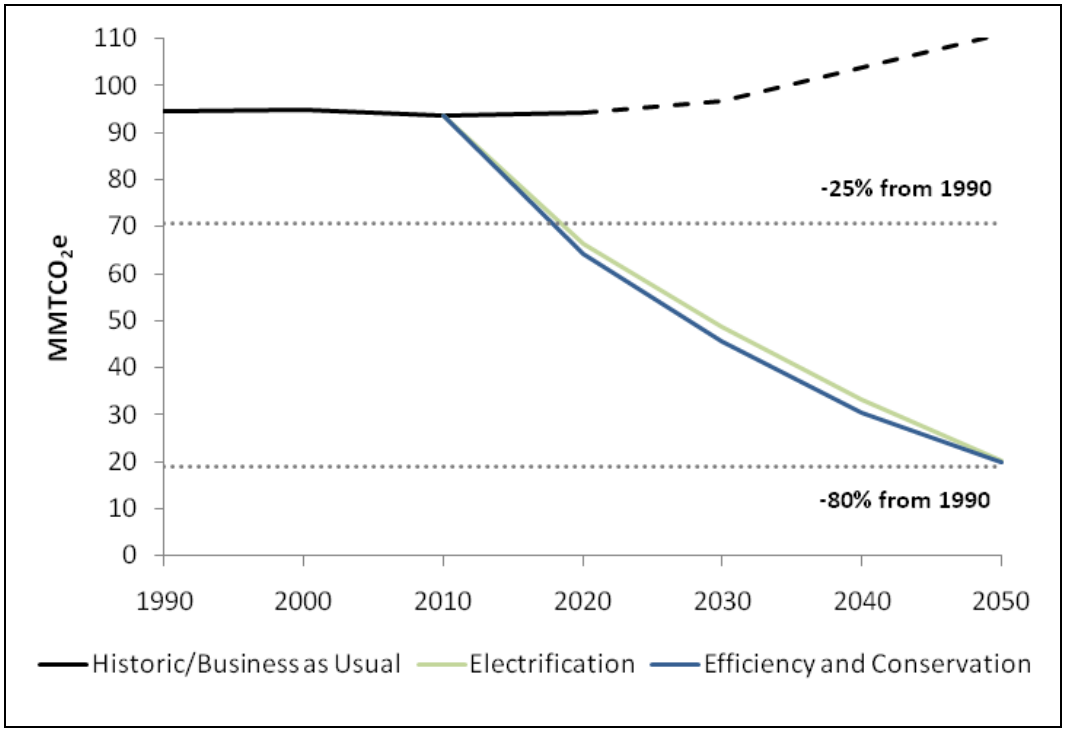


Figure 11. Historic and Projected Massachusetts GHG Emissions

The two scenarios have important commonalities, such as improvements in vehicle and building efficiency, shifts away from fossil fuels in transportation and buildings, and deployment of low carbon electricity generation. But they differ in how they combine demand- and supply-side approaches to reducing GHG emissions from energy use. In the electrification scenario, low-carbon supply rises greatly, to 112 percent of total Massachusetts electric consumption in 2007, or providing nine times the amount of low-carbon supply that Massachusetts consumed in 2007. In the efficiency and conservation scenario, the low-carbon supply only has to rise to about five times the 2007 amount.

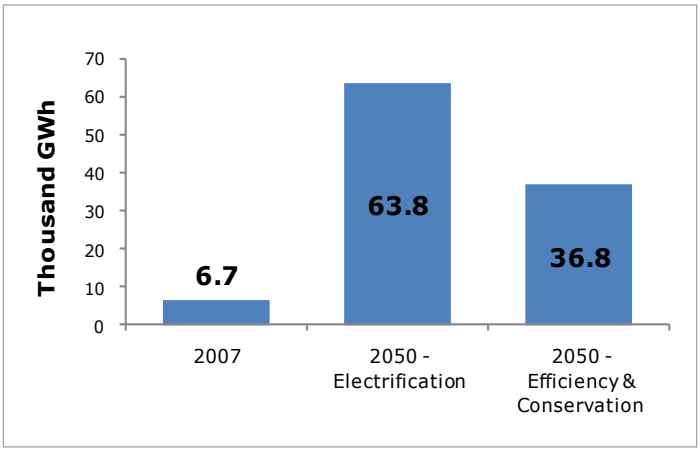


Figure 12. Supply of Near-Zero Carbon Electricity

In the efficiency and conservation scenario, enhanced efficiency measures and consumer choices produce lower transportation and buildings emissions than in the electrification scenario, notwithstanding some continued reliance on fossil fuels. These incremental gains make feasible a somewhat more carbon intensive energy supply. Figure 13 shows that the efficiency and conservation scenario allows for more emissions from electricity generation, whereas more non-emitting electricity sources are needed for the electrification scenario. Both scenarios require dramatic reductions in energy use, but the electrification scenario allows for somewhat greater electricity generation (from clean sources) even compared with today, while the efficiency and conservation scenario requires less energy use (and electricity generation) overall.

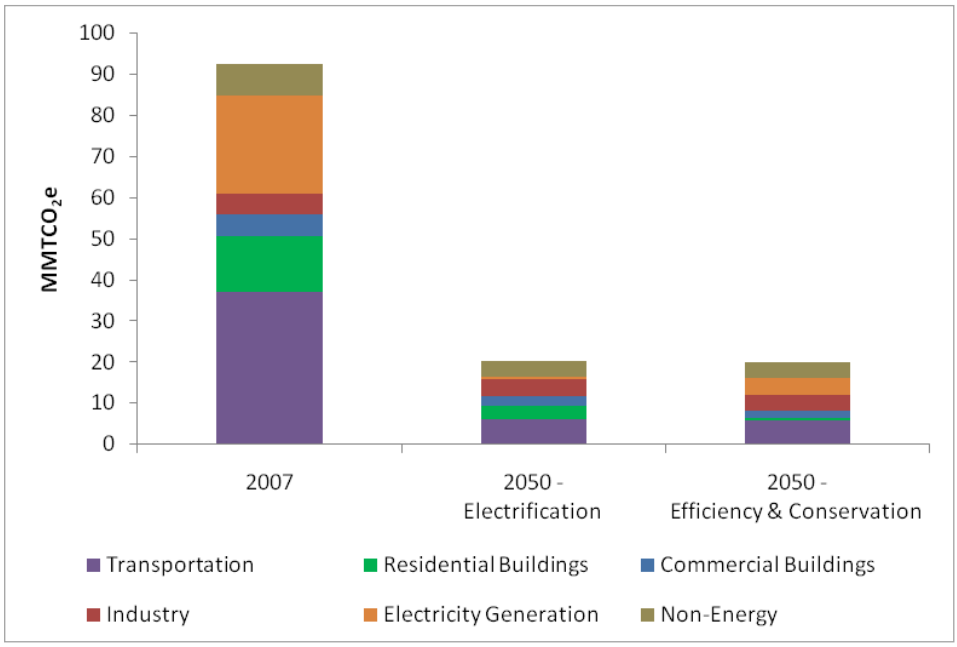


Figure 13. Emissions by sector in two scenarios.

The transportation and buildings sectors are by far the largest end users of energy in Massachusetts. Both scenarios count on considerable gains in building energy efficiency by 2050. These gains go further in the efficiency and conservation scenario, especially for existing houses — more of them are upgraded with energy saving measures and high efficiency mechanical systems. For residential buildings that exist in 2010, the electrification scenario assumes that energy demand per square foot is cut in half by 2050, while in the efficiency and conservation scenario it is cut by two-thirds. Homes that are built between 2010 and 2050 use even less energy, about 50 percent as much per square foot as existing buildings in the efficiency/conservation scenario.

There are three ways that transportation emissions can be reduced — reducing VMT, improving fuel efficiency, and reducing the carbon content of vehicle fuel. To achieve an 80 percent emissions reduction, all of these must achieve large gains relative to Business as Usual (BAU). In the electrification scenario, where vehicles are running almost entirely on low-carbon power, VMT for cars and light trucks is able to grow from 51 billion miles to 58 billion, while in the efficiency and conservation scenario it decreases to 48 billion miles, and the share of light trucks in the fleet drops steeply. Vehicle efficiency improves greatly in both scenarios, but more so in the efficiency and conservation scenario. Conversely, carbon emissions per unit of fuel are only about half as large in the electrification scenario, at 114 grams of CO_2 per kwh of energy input, as they are in the efficiency and conservation scenario (at 217 grams CO_2 per kwh).

Policy Directions to be Developed in Coming Years

As the scenarios show, reducing emissions by 80 percent in 2050 depends on dramatic changes in energy and transportation systems. Some of the policy changes that are critical to reaching the 2050 reduction requirement are included in the 2020 policies discussed earlier in this Plan. But the GHG reductions shown are relatively small, because these policies need long lead times for development and their impacts grow over time, becoming more significant after 2020. In addition, further new policies will be needed that are not necessary to reach the 2020 target, but are essential to reaching the 2050 mandate. Below we briefly review both sets of policy possibilities.

Policies in 2020 Plan that have relatively small impacts in 2020 but are critical for 2050

Buildings — As the scenarios show, on average energy use must drop by at least 42 percent for existing buildings in the electrification scenario and by 69 percent in the efficiency/conservation scenario by 2050. To accomplish this, policies to achieve much deeper reductions in energy use than result from the current utility programs will be needed. For new buildings, this can result largely from code requirements, while for existing buildings it is likely that other forms of incentives and regulatory requirements will be needed. Because buildings are so long-lasting, investments that are made in 2011 and beyond are likely to yield GHG savings for a century or more, while inefficiencies that are not rectified will produce excess emissions for decades. Four of the proposed policies to address this have been discussed in detail earlier in this Plan, but are worth re-emphasizing in their importance for 2050.

Building rating and labeling — At present, the likely energy use of existing buildings, both commercial and residential, is largely unknown to prospective purchasers and tenants. As a result, the built-in efficiency of a building (as distinct from occupant behavior) has little value in the marketplace. Rating the energy performance of buildings relative to an objective standard for others of the same size and type will make it possible for sales and rental prices to take energy use into account, giving owners an incentive to improve performance for resale value. In addition, rating and labeling are prerequisites to instituting performance requirements, which will become necessary over time in order to reduce the average consumption of existing buildings.

Building codes — To achieve the dramatic reductions in energy use that is needed for new buildings, building additions, and major renovations of existing buildings, continual updating of building codes is the most cost-effective policy. This will require conversion of traditional "prescriptive" codes, which dictate specific measures, to performance-based standards, and tightening over time of the energy requirements. Technological development, experience within the industry, and increases in the real cost of energy, along with an eventual price of carbon, should make such tightening cost effective. Recent trends and projections for the next few years in the IECC and American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) standards show that continual improvement in codes is feasible. Again, because buildings are so long-lasting, it is essential that improvements in the shells of new buildings (insulation and air sealing) be ramped up as quickly as possible.

Deep energy improvements — Today, utility-administered efficiency programs provide incentives for "moderate" retrofits of existing buildings, such as installing insulation in attics and in exterior wall cavities, purchasing compact fluorescent light bulbs and high-efficiency commercial light fixtures, and more efficient appliances. Achieving nearly universal adoption of such items should be sufficient to reach the 2020 GHG target, but not for 2050. "Deeper" retrofits, including such items as rigid insulation on the exterior walls of buildings under new siding, triple-glazed windows, LED lighting, and renewable heating systems, will all be needed.

Tree retention and planting — Because trees grow slowly, planting done in the next decade will have small benefits by 2020, but will contribute greatly to the 2050 target by reducing cooling and heating loads in buildings. In addition, though it is not counted in this Plan due to data limitations, planting more trees will result in greater sequestration of GHGs.

Transportation — to reduce transportation emissions on the order of 80 percent, all three of the primary drivers of emissions will have to be addressed — vehicle efficiency (including driving habits), miles driven, and carbon content of vehicle fuel. The measures below are some of the methods for influencing these three areas.

Smart Growth — To achieve the GHG target, VMT for light vehicles (cars and light trucks) must be reduced by 15 percent in the efficiency/conservation scenario versus the business-as-usual scenario. One of the primary influences on VMT is development pattern, with sprawling business and housing development increasing the amount of non-discretionary driving. This impact can be reduced through smart growth, which concentrates development in and around existing cities and in more compact areas with mixed residential, shopping, and employment uses to reduce transportation needs. Because development in Massachusetts is occurring slowly, the savings from smart growth are relatively small in 2020 but will be much greater in 2050. Without new development taking place primarily in smart growth fashion, however, it will not be possible to reach the necessary emissions reduction from transportation.

Low Carbon Fuel Standard (LCFS) — To achieve the 80 percent reduction limit, the average carbon content of vehicle fuel falls by 54 percent in the electrification scenario and by 12 percent in the efficiency / conservation scenario. This will require the conversion of a majority of motor vehicles from petroleum to other fuel sources, such as electricity or biofuels. The 2020 Plan anticipates that introduction of a LCFS will mandate a 5 percent reduction in the average carbon content of light vehicle fuel, contributing modestly to the 2020 limit. But for 2050 the LCFS must become far stricter, and be supported by other policies necessary for the LCFS to succeed (such as development of fueling infrastructure).

Policies not in the 2020 Plan that are needed for 2050

Beyond the measures described above and earlier in this Plan, the 2050 scenarios make clear that additional measures will be necessary to achieve an 80 percent GHG reduction at that time:

Decarbonizing the electricity supply — In both scenarios for 2050, the vast majority of electricity supply must be low-carbon (70 or 80 percent lower than the average emissions from the New England grid at present). Less of this supply is needed in the efficiency/lifestyle scenario than in the electrification scenario. The resources to achieve this shift are theoretically available, if not entirely in Massachusetts (given our small size and limited supply of renewable resources), then in imports from the region and beyond. The current RPS requires that the state's distribution utilities supply 15 percent of their power from qualifying renewable sources by 2020. For 2050 we will need far more resources from both RPS-eligible and non-RPS qualified sources. Part of this we expect will be obtained from offshore wind resources, which are ample in federal waters off Massachusetts. Part will come from non-RPS sources such as Canadian hydro and wind power. To ensure that sufficient supplies are available, new policy mechanisms will need to be developed that go beyond the RPS, such as the Clean Energy Performance Standard discussed earlier in this Plan.

Converting motor vehicles from petroleum to other fuels — The LCFS is the state's primary policy mechanism for encouraging a shift from petroleum to low-carbon vehicle fuels. However, there is evidence that the LCFS may not by itself be sufficient to cause this shift without complementary policies to induce consumers to shift to alternative fuels.[78] At least in part, this result stems from the difficulty in simultaneously developing alternative fuel sources, the infrastructure to distribute the fuels, and the vehicles that can utilize them. For example, converting a substantial portion of vehicle fuel to electricity requires that electric charging stations be installed at homes and businesses and at public locations, that auto manufacturers produce a variety of plug-in hybrid and all-electric vehicles, and that consumers purchase these vehicles in large numbers at a premium to conventional vehicles (at least in the early years). Substantial incentives for fueling infrastructure and for consumers to purchase the vehicles may be necessary.

[78] Based on results of system dynamics modeling conducted by Ventana Systems, Inc. on behalf of the state's CPGEA planning team.

V. Appendix

Methodology for Estimating Policy Impacts on Employment in 2020

State government policies affect employment in several ways. First, employment in a particular industry whose development is affected can be raised or lowered. Second, every industry buys goods and services from other industries, thus "indirectly" creating employment. And third, both employees and owners spend their incomes, creating "induced" employment. The size of employment changes depends greatly on what portion of an industry's income, and of household incomes, are spent within a state (or other geographic area being considered), and the capital- or labor-intensity of an industry, with labor-intensive ones generally yielding larger employment gains.

For purposes of this Plan, we have examined changes in the demand for the products of various industries, mainly those involved in energy production and consumption and in transportation. In general, the Commonwealth's and the federal government's energy and climate policies are designed to shift spending away from fossil fuels and toward energy efficiency and renewable energy, causing shifts in spending among industries. For example, federal fuel efficiency/vehicle CO_2 standards cause an increase in the cost of manufacturing autos, but the reduction in spending on gasoline and diesel fuel is several times larger than the higher manufacturing costs. Incomes of Massachusetts households rise by the difference between their savings on fuel and their extra spending on new vehicles, and, when they spend this money in Massachusetts, employment in Massachusetts rises. Income for auto manufacturers rises, but, since there are no auto plants in Massachusetts, almost all of this goes out of state, except for the small fraction gained by auto dealers. Income to the petroleum industry falls greatly, but this impact is primarily felt out of the state and out of the country, except for the reduced income to retailers. On balance, we estimate that in 2020 federal efficiency standards for light, medium, and heavy-duty vehicles will raise employment in Massachusetts by 7,000 jobs, driven by fuel savings that no longer go outside the Commonwealth, but that can now be spent in Massachusetts.

A similar procedure has been used for most of the major policies included in this Plan, wherever it was possible to make reliable estimates of the impact of a policy on energy production and consumption, and, as a result, on the incomes and expenses of various industries and on households. The first step in each case is to estimate the dollar value of changes in energy usage, and the amounts of higher or lower spending that will occur in each industry. To convert these to employment changes, several different models can be used; we have utilized the RIMS (Regional Input-Output Multiplier System) of the Bureau of Economic Analysis (BEA) in the U.S. Department of Commerce. Specifically, the RIMS Type II multipliers provide an estimate of the number of jobs in Massachusetts that result from an increase in spending of $1 million on an industry located in the Commonwealth — due to "direct" jobs within the industry itself, "indirect" jobs at suppliers to the industry, and "induced" jobs from spending by employees of the industry. The multipliers must be adjusted for the degree to which spending on an industry, or by an industry, goes out of the state — such as purchases of fuel or equipment from outside the Commonwealth.

When energy costs, such as electricity bills, fall, this is a gain to the incomes of both

households and businesses. To estimate the resulting employment changes, we need to know how much of the savings goes to households and to each type of business, and how each spend their money. The split between households and businesses can be obtained from the state's electric utilities. Then, for households, we have used the Consumer Expenditure Survey of the U.S. Bureau of Labor Statistics as the basis for how families will spend their energy savings. Combining this with the employment multipliers for each industry, we have constructed an employment multiplier for household spending. For businesses, we have used BEA data on the share of Massachusetts Gross Domestic Product coming from each industry, in combination with BEA multiplier data that shows the percentage of each industry's spending that goes to utility costs. These two data sources, then combined with the overall employment multipliers for each industry, give us an estimate of what the employment change will be in Massachusetts for a change of $1 million in business spending on electricity bills.

This procedure was used for those policies where the dominant change was a reduction in fossil fuel spending, and the changes to other industries in Massachusetts could be predicted with some reliability — which includes federal and state vehicle efficiency policies, policies to affect vehicle miles traveled, utility-administered buildings efficiency policies, building codes, and federal appliance/product efficiency standards. However, for renewable energy policies, more of the employment impact comes from growth in the renewable energy industries themselves, including equipment and fuel supplies. For these, we lack Massachusetts-specific studies on the likely development of relevant businesses within the Commonwealth by 2020 — such as manufacturing of solar photovoltaic panels or wind turbines, or conversion of biomass into cellulosic biofuels. We have therefore utilized national-level studies of employment changes due to increased reliance on renewable energy (primarily electricity), some of which have provided state-by-state estimates. However, such studies have not, in general, predicted the degree to which renewable energy industries will develop to differing degrees within different states. These studies usually provide results based either on the current status of the industries by state, or simply based on the overall size of a state's economy. For this reason, in our results shown in this Plan, we have given a broad range for possible employment in 2020 from renewable energy industries.

In most cases, policies as they existed prior to 2008 are considered part of the BAU trend for GHG emissions — for example a portion of savings from building codes and federal appliance standards. Only the post-2008 expansion of programs or creation of new programs are counted as causing reductions from the BAU in GHG. Consequently, energy savings, and the resulting jobs, deriving from pre-2008 policies have in most cases not been counted here. However, the Massachusetts DPU requires DOER to report on the impacts of all efficiency spending, including the level that existed prior to 2008. In order to be consistent with the figures reported to the DPU, the employment figures shown here are based on all efficiency spending.

Sources for transportation and buildings efficiency estimates: RIMS II multipliers for Massachusetts, Bureau of Economic Analysis, U.S. Department of Commerce, December 2010; Consumer Expenditure Survey 2009, Northeast states, U.S. Bureau of Labor Statistics; Gross Domestic Product by Industry for Massachusetts 2009, Bureau of Economic Analysis, U.S. Department of Commerce.

Sources for renewable energy estimates: "Economic Impacts of Extending Federal Solar Tax Credits," Navigant Consulting, Burlington, MA, Sept. 15, 2008; "Wind Turbine Development: Location of Manufacturing Activity," George Sterzinger and Matt Svrcek, Renewable Energy Policy Project, Sept. 2004; "Solar PV Development: Location of Economic Activity," George Sterzinger and Matt Svrcek, Renewable Energy Policy Project, January 2005; "The Economic Benefits of Investing in Clean Energy," Robert Pollin et al, Political Economy Research Institute and Center for American Progress, June 2009; "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?," Daniel M. Kammen et al, Renewable and Appropriate Energy Laboratory, Goldman School of Public Policy, University of California - Berkeley, April 13, 2004 (corrected 1/31/2006).

VI. References

Akbari, H. (2002) "Shade trees reduce building energy use and CO_2 emissions from power plants." Environmental Pollution 116: S119-S126

American Automobile Association. (March 2008) Crashes vs. Congestion, What's the Cost to Society?

Bordoff, Jason E., and Pascal J. Noel. (July 2008) Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity. The Hamilton Project, The Brookings Institution.

Brown, Marilyn A., Frank Southworth, and Therese K. Stovall. (June 2005). Towards a Climate-Friendly Built Environment. Prepared for the Pew Center on Global Climate Change. Published online at: http://www.pewclimate.org/docUploads/Buildings_FINAL.pdf

Burchell, Robert W., William R. Dolphin, and Catherine C. Galley. (2000) Impact Assessment of the New Jersey State Development and Redevelopment Plan. New Jersey: Rutgers University for Urban Policy Research.

Burchell, R.W. and S. Mukherji (2003) "Conventional Development Versus Managed Growth: The Costs of Sprawl." American Journal of Public Health 93(9):1534-1540.

California Environmental Protection Agency Air Resources Board. (May 2008) Clearinghouse of Technological Options for Reducing Anthropogenic Non-CO_2 GHG Emissions from All Sectors, Chapter 4 - High-GWP Gases. Published online at: http://www.arb.ca.gov/research/apr/past/05-328.pdf and http://www.arb.ca.gov/cc/non-co2-clearinghouse/non-co2-clearinghouse.htm

California Environmental Protection Agency Air Resources Board. "HFC Emission Reduction Measures for Mobile Air Conditioning — Low Emission Vehicle (LEV III), MAC Effort." Published online, retrieved Dec. 8, 2010 from http://www.arb.ca.gov/cc/hfc-mac/mvac-gwp/mvac-gwp.htm

California Environmental Protection Agency Air Resources Board, "Global Warming Potential Refrigerants." Published online, retrieved Dec. 8, 2010 from http://www.arb.ca.gov/regact/2009/gwprmp09/gwprmp09.htm

California Environmental Protection Agency Air Resources Board, "SF_6 Gas Insulated Switchgear." Published online, retrieved Dec. 8, 2010 from http://www.arb.ca.gov/regact/2010/sf6elec/sf6elec.htm

California Environmental Protection Agency Air Resources Board, "California Electricity Sector and Particle Accelerator Sulfur Hexaflouride (SF_6) Survey." Published online, retrieved Dec. 8, 2010 from http://www.arb.ca.gov/cc/sf6elec/survey/sf6survey.doc

California Environmental Protection Agency Air Resources Board. (Dec. 2008). Climate Change Scoping Plan, A Framework for Change. Published online at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

California Environmental Protection Agency Air Resources Board, Research Division. (October 2009) High-Global Warming Potential Stationary Source Refrigerant Management Program Published online at: http://www.arb.ca.gov/regact/2009/gwprmp09/isorref.pdf

Cambridge Systematics, Inc. (2009) Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions. Washington, D.C., Urban Land Institute.

Center for Climate Strategies. "Home Page." Published online, retrieved Dec. 8, 2010 from http://www.climatestrategies.us/

Clean Edge. (April 2010) A Future of Innovation and Growth: Advancing Massachusetts' Clean Energy Leadership. MassCEC.

Comerica. (May 2010) Auto Affordability Index. Published online at: http://www.comerica.com/Comerica_Content/Corporate_Communications/Docs/Auto%20Affordability%20Index/Auto_Affordability_Index_Q12010.pdf

Commonwealth of Massachusetts. "Governor Deval Patrick: Energy and the Environment." Published online, retrieved on October 27, 2010 from http://www.mass.gov/?pageID=gov3utilities&sid=Agov3&U=energyandenvironment

Commonwealth of Massachusetts. (Spring 2008) Advanced Biofuels Task Force Report. Page 20. Published online at: http://www.mass.gov/Agov3/docs/biofuels.pdf

Commonwealth of Massachusetts. (July 2008) Clean Energy Biofuels Act, Chapter 206 of the Acts of 2008. Published online at: http://www.malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter206

Commonwealth of Massachusetts. Massachusetts General Law Chapter 111, Section 142 K "Motor Vehicle Emission Standards; Late Models." Published online at: http://www.malegislature.gov/Laws/GeneralLaws/PartI/TitleXVI/Chapter111/Section142K

Commonwealth of Massachusetts, Department of Environmental Protection. (July 1, 2010) News Release: "Patrick-Murray Administration Releases Draft Solid Waste Master Plan for 2010-2020." Published online at: http://www.mass.gov/dep/public/press/0710swmp.htm

Commonwealth of Massachusetts, Department of Environmental Protection. "Waste and Recycling — Priorities and Results." Published online, retrieved on Dec. 8, 2010 from http://www.mass.gov/dep/recycle/priorities/dswmpu01.htm#swmp

Commonwealth of Massachusetts, Department of Public Health. (2009) Maximizing our Efforts: The Massachusetts State Injury Prevention Plan. Published online at: www.mass.gov/Eeohhs2/docs/dph/com_health/injury/injury_prevention_plan.pdf

http://www.mass.gov/Eeohhs2/docs/dph/com_health/injury/injury_prevention_plan.doc

Commonwealth of Massachusetts, Department of Transportation — Highway Division. "Average Crash Rates." Published online, retrieved on Dec. 14, 2010 from http://www.mhd.state.ma.us/default.asp?pgid=content/traffic/crashrate&sid=about

Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs. (October 28, 2010) News Release: "Patrick-Murray Administration Highlights Growth of Solar Industry with Visit to Solar Inverter Manufacturer." Published online at: http://www.mass.gov/?pageID=eoeeapressrelease&L=1&L0=Home&sid=Eoeea&b=pressrelease&f=101028_pr_solar&csid=Eoeea

Ewing, Reid, Keith Bartholomew, Steve Winkelman, Jerry Walters and Don Chen, with Barbara McCann and David Goldberg. (2008) Growing Cooler: The Evidence on Urban Development and Climate Change. Washington, D.C.: Urban Land Institute.

Eastern Research Group (2010) Final Report to the Climate Protection and Green Economy Advisory Committee.

Ferreira, Jr., Joseph, and Eric Minikel. (November 2010) Pay-As-You-Drive Auto Insurance In Massachusetts: A Risk Assessment And Report On Consumer, Industry And Environmental Benefits. Commissioned by Conservation Law Foundation & Environmental Insurance Agency.

Gelman, Emmaia, Editor. (May 2009) Green Jobs/Green Homes New York: Expanding home energy efficiency and creating good jobs in a clean energy economy. Center for Working Families, Green Jobs New York and Center for American Progress. Page 5. Published online at: http://www.americanprogress.org/issues/2009/05/pdf/ghgjny_v10.pdf

Global Insight, Inc., (2007) Massachusetts Clean Energy Census. Massachusetts Technology Collaborative. Published online at: http://www.cleanenergycouncil.org/files/Clean-Energy-Census-Report-2007.pdf

Goulder, L.H, M. R. Jacobsen, and A.A. van Benthem. (2009) "Impacts of State-Level Limits on Greenhouse Gases per Mile In the Presence of National CAFE Standards." Published online at: http://www.stanford.edu/~goulder/Pavley-CAFE%20Paper%20%28Goulder-Jacobsen-van%20Benthem%29.pdf

Grossman, Richard and Gail Daneker. (1979) Energy, Jobs and the Economy. Boston, MA: Alyson Publications.

H.C. Planning Consultants, Inc., and Planimetrics, LLP. (1999) .The Cost of Suburban Sprawl and Urban Decay in Rhode Island. Providence, RI: Grow Smart Rhode Island.

Huang, Y.J., H. Akbari, H Taha, and A.H. Rosenfeld. (1987) "The Potential of Vegetation in Reducing Summer Cooling Loads in Residential Buildings." Journal of Climate and Applied Meteorology. 26:1103-1116.

Intergovernmental Panel on Climate Change. (2005) Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons. Published online at: http://books.google.com/books?id=Qf0MVNcQKmQC&printsec=frontcover&dq=Safeguarding+the+Ozone+Layer+and+the+Global+Climate+System:+Issues+Related+to+Hydrofluorocarbons+and+Perfluorocarbons&source=bl&ots=5tP0u2fN9q&sig=cvbg-cIUYRYSdi7h0RzraQDGM_U&hl=en&ei=wd0HTdh9wfrwBr6fge0G&sa=X&oi=book_result&ct=result&resnum=5&ved=0CC0Q6AEwBA#v=onepage&q&f=false

The International Council on Clean Transportation (April 2010). Best Practices for Feebate Program Design and Implementation.

Iowa Department of Transportation, Transportation and Engineering Division. (1995) Miles, Vehicle Miles, Accidents and Accident Rates in Iowa By Road System, 1989-1993.

Kammen, Daniel M., et.al. (April 2004; corrected January 2006) "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?" Renewable and Appropriate Energy Laboratory, Goldman School of Public Policy, University of California — Berkeley.

Katz, Bruce. "Smart Growth Saves Money." The Detroit News. Published on April 13, 2003, retrieved Dec. 7, 2010 from http://www.brookings.edu/opinions/2003/0413metropolitanpolicy_katz.aspx?p=1

Konopacki, S. and H. Akbari. (2002) "Energy Savings for Heat-Island Reduction Strategies in Chicago and Houston" (including updates for Baton Rouge, Sacramento, and Salt Lake City. Lawrence Berkeley National Laboratory LBNL-49638.

Konopaki, S. and H. Akbari. (2001) "Energy Impacts of Heat Island Reduction Strategies in Toronto, Canada." Lawrence Berkeley National Laboratory.

Litman, Todd. (June 2008). "Distance Based Vehicle Insurance Feasibility, Costs and Benefits." Victoria Transport Policy Institute.

McPherson, E.G., and J.R. Simpson. (1999) "Carbon dioxide reduction through urban forestry: Guidelines for professional and volunteer tree planters." Gen. Tech. Rep. PSW-GTR-171. Albany, CA: Pacific Southwest Research Station, Forest Service, US Dept. of Agriculture.

McPherson, E.G. and Rountree, R.A. (1993) "Energy conservation potential of urban tree planting." Journal of Arboriculture 19(6):321-331.

Minnesota Department of Transportation. (March 2006) "Mileage-Based User Fee Demonstration Project: Potential Public Policy Implications of Pay-As-You-Drive Leasing and Insurance Products."

Mullan, Jeffrey B. (2010) MassDOT Policy Directive on GreenDOT. Massachusetts Department of Transportation.

Navigant Consulting. (September 2008) "Economic Impacts of Extending Federal Solar Tax Credits." Prepared for the Solar Energy Research and Education Foundation.

Nowak, D.J. (1994) "Air pollution removal by Chicago's urban forest." Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project. USDA Forest Service General Technical Report NE- 186. McPherson, E.G., Nowak, D.J., Rountree, R.A.(Eds.), pp. 63-81.

O'Connor, John T., and Marc Breslow et. al, (January 1997) The Massachusetts Green Jobs Report: How to Create 100,000 Jobs While Cleaning the Environment. GreenWorks. Table 2, page 16.

Oregon Department of Transportation. (November 2007) Oregon's Mileage Fee Concept and Road User Fee Pilot Program Final Report.

Pollin, Robert, et.al. (September 2008) Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy. Political Economy Research Institute and Center for American Progress. Page 10.

Pollin, Robert, et.al. (June 2009) The Economic Benefits of Investing in Clean Energy. Political Economy Research Institute and Center for American Progress.

Riverside Public Utilities. "Tree Power." Published online, retrieved on Dec. 7, 2010 from http://www.riversideca.gov/UTILITIES/resi-treepower.asp

Sacramento Municipal Utility Department. "Free Shade Trees." Published online, retrieved on Dec. 7, 2010 from http://www.smud.org/en/residential/trees/Pages/index.aspx

Sacramento Tree Foundation. "Sacramento Shade." Published online, retrieved on Dec. 7, 2010 from http://www.sactree.com/doc.aspx?25

Sterzinger, George and Matt Svrcek. (January 2005) Solar PV Development: Location of Economic Activity. Renewable Energy Policy Project.

Sterzinger, George and Jerry Stevens. (August 2007) Component Manufacturing: Massachusetts's Future in the Renewable Energy Industry. Renewable Energy Policy Project.

Sterzinger, George and Matt Svrcek. (September 2004) Wind Turbine Development: Location of Manufacturing Activity. Renewable Energy Policy Project.

Texas Transportation Institute. (2009) Urban Mobility Report.

Trees Forever. "Home Page" Published online, retrieved on Dec. 7, 2010 from http://www.treesforever.org/

United States of America, 110th Congress. (January 2007). The Energy Independence and Security Act of 2007. Published online at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf

United States of America, 110th Congress (September 2008). The Energy Improvement and Extension Act of 2008. Published online at: http://www.gpo.gov/fdsys/pkg/BILLS-110hr6049eas/pdf/BILLS-110hr6049eas.pdf

United States Bureau of Labor Statistics. (2009) Consumer Expenditure Survey 2009.

United States Census Bureau. "2007 Economic Census." Published online, retrieved on Dec. 8, 2010 from http://www.census.gov/econ/census07/

United States Department of Commerce, Bureau of Economic Analysis. (2009) Gross Domestic Product by Industry for Massachusetts 2009.

United States Department of Commerce, Bureau of Economic Analysis. (Dec. 2010) RIMS II (Regional Input-Output Multiplier System) multipliers for Massachusetts 2007.

United States Department of Transportation Office of the Secretary of Transportation (February 5, 2008) Memorandum to Secretarial Officers Modal Administrators, "Re: Treatment of the Economic Value of a Statistical Life in Departmental Analysis."

United States Department of Transportation; Research and Innovative Technology Administration Bureau of Transportation Statistics. "Table 1-17: New and Used Passenger Cars Sales and Leases." Published online, retrieved Dec. 14, 2010 from http://www.bts.gov/publications/national_transportation_statistics/html/table_01_17.html

United States Department of Transportation; Research and Innovative Technology Administration Bureau of Transportation Statistics. "Table 2-1: Highway Traffic Fatalities and Fatality Rates 2008." Published online, retrieved Dec. 14, 2010 from http://www.bts.gov/publications/state_transportation_statistics/state_transportation_statistics_2009/html/table_02_01.html

United States Department of Transportation Federal Highway Administration. (2006) "Highway Performance Monitoring System Background Data."

United States Department of Transportation Federal Highway Administration. "Highway Statistics: Table VM-2 — Functional System Travel 2008 1/Annual Vehicle Miles." Published online at: http://www.fhwa.dot.gov/policyinformation/statistics/2008/vm2.cfm

United States Environmental Protection Agency. "GreenChill Advanced Refrigeration Partnership." Published online, retrieved Dec. 8, 2010 from http://www.epa.gov/ozone/partnerships/greenchill/

United States Environmental Protection Agency. "GreenChill Store Certification Program." Published online, retrieved Dec. 8, 2010 from http://www.epa.gov/ozone/partnerships/greenchill/certcenter.html

United States Environmental Protection Agency. "Climate Change — Regulatory Initiatives, Subpart DD — Use of Electric Transmission and Distribution Equipment." Published online, retrieved Dec. 8, 2010 from http://www.epa.gov/climatechange/emissions/subpart/dd.html

United States Environmental Protection Agency. "SF_6 Emission Reduction Partnership for Electric Power Systems." Published online, retrieved Dec. 8, 2010 from http://www.epa.gov/electricpower-sf6/

United States Environmental Protection Agency. (April 2010) Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Regulatory Impact Analysis, EPA-420-R-10-009. Published online at: http://www.epa.gov/otaq/climate/regulations/420r10009.pdf

United States Environmental Protection Agency. (2006) Global Mitigation of Non-CO_2 Greenhouse Gases EPA Report 430-R-06-005. Published online at: http://www.epa.gov/climatechange/economics/downloads/GlobalMitigationFullReport.pdf

United States Environmental Protection Agency and Department of Transportation National Highway Traffic Safety Administration. (October 2010). "EPA and NHTSA Propose First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles: Regulatory Announcement" Report No. EPA-420-F-10-901. Published online at: http://www.epa.gov/oms/climate/regulations/420f10901.pdf

Vickrey. Automobile Accidents, Tort Law, Externalities and Insurance: An Economist's Critique. Law and Contemporary Problems 33: 464–87, 1968.

B-285

Print

Acts 2008

CHAPTER 114 AN ACT RELATIVE TO OCEANS.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:

SECTION 1. Chapter 10 of the General Laws is hereby amended by inserting after section 35GG the following section:-

Section 35HH. There shall be established and set up on the books of the commonwealth a separate fund to be administered by the secretary of energy and environmental affairs, as trustee, in consultation with the department of environmental protection, to be known as the Ocean Resources and Waterways Trust Fund. There shall be credited to the fund any revenue from appropriations or other monies authorized by the general court and specifically designated to be credited to the fund, any appropriation or grant explicitly made to the fund and any income derived from the investment of amounts credited to the fund and the proceeds from any ocean development mitigation fees established pursuant to section 18 of chapter 132A. The priority for use of funds derived from compensation or mitigation for ocean development projects shall be to restore or enhance marine habitat and resources impacted by the project for which the compensation or mitigation shall have been received. The funds derived from compensation or mitigation related to public navigational impacts shall be dedicated to public navigational improvements; provided, however, that any funds for the enhancement of fisheries resources shall be directed to conduct fisheries restoration and management programs. Any other amounts credited to the fund shall be used, without further appropriation, only for the purposes of environmental enhancement, restoration and management of ocean resources by the secretary pursuant to section 4C of chapter 21A. No expenditure from the fund shall cause the fund to be in deficiency at the close of a fiscal year. Monies deposited in the fund that are unexpended at the end of the fiscal year shall not revert to the General Fund and shall be available for expenditure in the subsequent fiscal year.

SECTION 2. Chapter 21A of the General Laws is hereby amended by inserting after section 4B the following section:-

Section 4C. (a) The ocean waters and ocean-based development of the commonwealth, within the ocean management planning area described in this section, shall be under the oversight, coordination and planning authority of the secretary of energy and environmental affairs, hereinafter referred to as the secretary, in accordance with the public trust doctrine. Notwithstanding any general or special law to the contrary, the secretary, in consultation with the ocean advisory commission established pursuant to subparagraph (c) and the ocean science advisory council established pursuant to

subparagraph (d), shall develop an integrated ocean management plan, which may include maps, illustrations and other media. The plan shall: (i) set forth the commonwealth's goals, siting priorities and standards for ensuring effective stewardship of its ocean waters held in trust for the benefit of the public; and (ii) adhere to sound management practices, taking into account the existing natural, social, cultural, historic and economic characteristics of the planning areas; (iii) preserve and protect the public trust; (iv) reflect the importance of the waters of the commonwealth to its citizens who derive livelihoods and recreational benefits from fishing; (v) value biodiversity and ecosystem health; (vi) identify and protect special, sensitive or unique estuarine and marine life and habitats; (vii) address climate change and sea-level rise; (viii) respect the interdependence of ecosystems; (ix) coordinate uses that include international, federal, state and local jurisdictions; (x) foster sustainable uses that capitalize on economic opportunity without significant detriment to the ecology or natural beauty of the ocean; (xi) preserve and enhance public access; (xii) support the infrastructure necessary to sustain the economy and quality of life for the citizens of the commonwealth; (xiii) encourage public participation in decision-making; (xiv) and adapt to evolving knowledge and understanding of the ocean environment; and (xv) shall identify appropriate locations and performance standards for activities, uses and facilities allowed under sections 15 and 16 of chapter 132A. The division of marine fisheries, pursuant to chapter 130 and any other applicable general or special law, shall have sole responsibility for developing and implementing any fisheries management plans or fisheries regulations. Marine fisheries shall be managed in compliance with the applicable rules and regulations of the division of marine fisheries and federal or interstate fishery management plans issued pursuant to said chapter 130 or any other applicable general or special law and shall be integrated, to the maximum extent practicable, with an ocean management plan.

(b) An ocean management plan shall include any waters and associated submerged lands of the ocean, including the seabed and subsoil, lying between the line designated as the "Nearshore Boundary of the Ocean Management Planning Area", which is depicted on a plan dated January 31, 2006, prepared by the office of coastal zone management and maintained at the executive office of energy and environmental affairs and with the clerks of the house and the senate, and the seaward boundary of the commonwealth, as defined in 43 U.S.C. § 1312. An ocean management plan may take into account the different regional characteristics of the commonwealth's waters. A plan shall include existing municipal, state and federal boundaries and may include recommendations for clarifying those boundaries.

(c)(i) There shall be an ocean advisory commission to assist the secretary in developing the ocean management plan. The commission shall consist of 3 members of the senate, 1 of whom shall be appointed by the minority leader of the senate; 3 members of the house of representatives, 1 of whom shall be appointed by the minority leader of the house of representatives; the director of coastal zone management or his designee; the director of marine fisheries or his designee; the commissioner of environmental protection or his designee; and 8 members to be appointed by the governor, 1 of whom shall be a representative of a commercial fishing organization, 1 of whom shall be a representative of an environmental organization, 1 of whom shall have expertise in the development of offshore

B-287

renewable energy, 1 of whom shall be a representative of the Cape Cod commission, 1 of whom shall be a representative of the Martha's Vineyard Commission, 1 of whom shall be a representative of the Merrimack Valley Planning Commission, 1 of whom shall be a representative of the metropolitan area planning council and 1 of whom shall be a representative of the Southeastern Regional Planning and Economic Development District. Members shall be appointed for terms of 3 years, except that, initially, 4 members appointed by the governor shall be appointed for terms of 2 years and 3 members appointed by the governor shall be appointed for terms of 1 year. The appointing authority may fill any vacancy that occurs in an unexpired term. The members of the commission shall be selected with due regard to coastal geographic distribution.

(ii) The commission shall meet at least quarterly and at the discretion of the secretary. The commission shall hold public meetings relative to matters within the jurisdiction of the ocean management plan and shall make recommendations to the secretary for the proper management and development of the plan. The secretary shall consider the recommendations of the commission.

(iii) The office of coastal zone management and division of marine fisheries shall provide technical support to the commission.

(d) There shall be an ocean science advisory council to assist the secretary in creating a baseline assessment and obtaining any other scientific information necessary for the development of an ocean management plan. The council shall consist of 9 members to be appointed by the secretary, 3 of whom shall be scientists from academic institutions, at least 1 of whom shall be from the School for Marine Science and Technology at the University of Massachusetts at Dartmouth and at least 1 of whom shall be from the Department of Environmental, Earth and Ocean Sciences at the University of Massachusetts at Boston; 3 of whom shall be scientists from private, nonprofit organizations, at least 1 of whom shall be a scientist designated by the Massachusetts Fishermen's Partnership; and 3 of whom shall be scientists from government agencies with demonstrated technical training and experience in the fields of marine ecology, geology, biology, ichthyology, mammalogy, oceanography or other related ocean science disciplines, at least 1 of whom shall be from the division of marine fisheries. The secretary shall serve as coordinator of the council. The council shall meet at least quarterly and at any other time that the secretary shall deem necessary to assist him in compiling the scientific information necessary for the development of an ocean management plan.

(e) Upon the secretary's adoption of an ocean management plan, all certificates, licenses, permits and approvals for any proposed structures, uses or activities in areas subject to the ocean management plan shall be consistent, to the maximum extent practicable, with the plan.

(f) The secretary shall develop and implement a public outreach and information program to provide information to the public regarding the ocean management planning process.

(g) The secretary shall, at least 6 months before establishing an ocean management plan pursuant to

this section, provide for public access to the draft plan in electronic and printed copy form and shall provide for a public comment period, which shall include at least 4 public hearings in at least 4 different coastal regions. The secretary shall publish notice of the hearings in the Environmental Monitor within 30 days of the date of the hearing. A notice of the public hearing shall also be placed, at least once each week for the 4 consecutive weeks preceding the hearing, in newspapers with sufficient circulation to notify the residents of the coastal region where the hearing shall be held. The hearing shall be held not sooner than 30 days and not later than 35 days after the notice is published in the Environmental Monitor. The public comment period shall remain open for at least 60 days from the date of the final public hearing. After the close of the public comment period, the secretary shall issue a final ocean management plan and shall file the plan, together with legislation necessary to implement the plan, if any, by filing the same with the clerks of the house of representatives and senate.

(h) The secretary shall promulgate regulations to implement, administer and enforce this section and shall interpret this section and any regulations adopted hereunder consistent with his power to enforce the laws. These regulations shall include provisions for the review of the ocean management plan, its baseline assessment and the enforceable provisions of relevant statutes and regulations at least once every 5 years.

(i) The joint committee on state administration and regulatory oversight, in this subsection called the committee, may review a proposed ocean management plan or regulations proposed or adopted pursuant to this chapter. The committee shall consult with the joint committee on environment, natural resources and agriculture in performing this review. The committee may hold public hearings concerning a proposed ocean management plan or a proposed or existing regulation and may submit to the secretary comments concerning the merit and appropriateness of the plan or regulations to be promulgated and an opinion on whether the proposed plan or regulations are authorized by, and consistent with, this chapter and existing state laws and regulations. The secretary shall respond in writing within 10 days to the committee's written questions relevant to the committee's review of a proposed plan or proposed or existing regulation. The secretary shall provide to the committee, without charge, copies of all public records in the secretary's custody relating to the proposed plan or regulation or action in question within 10 days of a request by the committee. The committee may issue a report with proposed changes to a proposed plan or proposed or existing regulation and shall transmit this report to the secretary. If the secretary does not adopt the proposed changes contained in the committee's report, the secretary shall notify the committee in writing of the reasons why he did not adopt the changes either at the time he adopts a proposed plan or proposed regulation or within 21 days of receiving the committee's report on an existing regulation.

(j) The ocean management plan shall be consistent with this section and all other general and special laws. The ocean management plan shall not be construed to supersede existing general or special laws, or to confer rights and remedies in addition to those conferred by existing general or special

B-289

laws.

(k)(1) In the geographic area subject to the ocean management plan, as described in paragraph (b), commercial and recreational fishing shall be allowable uses, subject to the exclusive jurisdiction of the division of marine fisheries. Any component of a plan which regulates commercial or recreational fishing shall be developed, promulgated and enforced by the division of marine fisheries pursuant to its authority under chapter 130.

(2) A component of an ocean management plan which does not have as its primary purpose the regulation of commercial or recreational fishing but which has an impact on such fishing shall minimize negative economic impacts on commercial and recreational fishing. Prior to inclusion in an ocean management plan, a component with such a reasonably foreseeable impact shall be referred to the division of marine fisheries, which shall, in writing and in a timely and efficient manner, evaluate the component for its impact on commercial and recreational fishing and, if possible, develop and recommend to the secretary any suggestions or alternatives to mitigate or eliminate any adverse impacts.

(3) The director of marine fisheries, subject to the approval of the marine fisheries advisory commission, shall have sole authority for the opening and closing of areas within the geographic area described in subsection (b) for the taking of any and all types of fish, pursuant to section 17A of chapter 130. Nothing in this section shall be construed to limit the powers of the director pursuant to section 17 of chapter 130 or any other provision thereto.

SECTION 3. Section 12B of chapter 132A of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by striking out the definitions of “Commissioner” and “Department” and inserting in place thereof the following definition:-

“Director”, the director of coastal zone management.

SECTION 4. Said section 12B of said chapter 132A, as so appearing, is hereby further amended by inserting after the definition of “Facilities plan” the following definition:-

“Office”, office of coastal zone management.

SECTION 5. Section 12C of said chapter 132A, as so appearing, is hereby amended by striking out, in lines 1 and 3, the word “department” and inserting in place thereof, in each instance, the following word:- office.

SECTION 6. Section 14 of said chapter 132A, as so appearing, is hereby amended by striking out, in line 2, the word “department” and inserting in place thereof the following word:- office.

B-290

SECTION 7. Said chapter 132A, as so appearing, is hereby further amended by striking out section 15 and inserting in place thereof the following section:-

Section 15. Except as otherwise provided in this section, the following activities shall be prohibited in an ocean sanctuary:

(1) the building of any structure on the seabed or under the subsoil;

(2) the construction or operation of offshore or floating electric generating stations, except: (a) on an emergency and temporary basis for the supply of energy when the electric generating station is otherwise consistent with an ocean management plan; or (b) for appropriate-scale renewable energy facilities, as defined by an ocean management plan promulgated pursuant to section 4C of chapter 21A, in areas other than the Cape Cod Ocean Sanctuary; provided, however, that (i) the renewable energy facility is otherwise consistent with an ocean management plan; (ii) siting of all such facilities shall take into account all relevant factors, including but not limited to, protection of the public trust, compatibility with existing uses, proximity to the shoreline, appropriateness of technology and scale, environmental protection, public safety and community benefit; and (iii) in regions where regional planning agencies have regulatory authority, a regional planning agency may review the appropriate-scale offshore renewable energy facilities as developments of regional impact and the applicant may seek review pursuant to the authority of the energy facilities siting board to issue certificates of environmental impact and public interest pursuant to sections 69K through 69O of chapter 164;

(3) the drilling or removal of any sand, gravel or other minerals, gases or oils;

(4) the dumping or discharge of commercial, municipal, domestic or industrial wastes;

(5) commercial advertising; or

(6) the incineration of solid waste or refuse on, or in, vessels moored or afloat within the boundaries of an ocean sanctuary.

SECTION 8. Section 16 of said chapter 132A, as so appearing, is hereby amended by striking out, in lines 14 and 15, the words “telecommunications and energy” and inserting in place thereof the following words:- public utilities or the department of telecommunications and cable.

SECTION 9. Said section 16 of said chapter 132A, as so appearing, is hereby further amended by striking out, in line 20 and in lines 28 and 29, the word “department” and inserting in place thereof, in each instance, the following word:- office.

SECTION 10. Said section 16 of said chapter 132A, as so appearing, is hereby further amended by striking out, in lines 29 and 30, the words “fisheries, wildlife and environmental law enforcement” and inserting in place thereof the following words:- fish and game.

B-291

SECTION 11. Section 16A of said chapter 132A, as so appearing, is hereby amended by inserting after the word “department”, in line 6, the following words:- of environmental protection.

SECTION 12. Section 16B of said chapter 132A, as so appearing, is hereby amended by striking out, in line 26 and in lines 30 and 31, the words “and the division of water pollution control” and inserting in place thereof the following words:- of environmental protection.

SECTION 13. Section 16C of said chapter 132A, as so appearing, is hereby amended by inserting after the word “department”, in lines 1 and 5, the following words:- of environmental protection.

SECTION 14. Section 16E of said chapter 132A, as so appearing, is hereby amended by inserting after the word “department”, in lines 1 and 2 and line 5, the following words:- of environmental protection.

SECTION 15. Said section 16E of said chapter 132A, as so appearing, is hereby further amended by inserting after the word “commissioner”, in lines 13 and 14, the following words:- of environmental protection.

SECTION 16. Section 16F of said chapter 132A, as so appearing, is hereby amended by inserting after the word “department”, in line 1, the following words:- of environmental protection.

SECTION 17. Said section 16F of said chapter 132A, as so appearing, is hereby further amended by striking out the last sentence.

SECTION 18. Section 18 of said chapter 132A, as so appearing, is hereby amended by inserting, after the word “of”, in line 2, the following words:-energy and.

SECTION 19. Said section 18 of said chapter 132A, as so appearing, is hereby further amended by striking out, in lines 7 and 8 and line 9, the word “department” and inserting in place thereof, in each instance, the following word:- office.

SECTION 20. Said section 18 of said chapter 132A, as so appearing, is hereby further amended by adding the following paragraph:-

Any permit or license issued by a department, division, commission, or unit of the executive office of energy and environmental affairs and other affected agencies or departments of the commonwealth for activities or conduct consistent with this chapter shall be subject to an ocean development mitigation fee as shall be established by the secretary of energy and environmental affairs; provided, however, that no fee shall be assessed on commercial and recreational fishing permits or licenses. All

B-292

the proceeds of the ocean development mitigation fee shall be deposited in the Ocean Resources and Waterways Trust Fund established pursuant to section 35HH of chapter 10.

SECTION 21. Nothing in this act shall be construed to alter the jurisdictional authority of the division of marine fisheries. Nothing in this act shall be construed to prohibit the transit of commercial fishing vessels and recreational vessels in state ocean waters.

SECTION 22. Any project that, before the effective date of this act, has: (1) filed a license application under chapter 91 of the General Laws and received a written determination of completeness from the department of environmental protection; (2) if subject to section 61 of chapter 30 of the General Laws, received a certificate of adequacy regarding a final environmental impact report; or (3) if the project is subject to the jurisdiction of the energy facilities siting board, received both a final decision from the energy facilities siting board and a certificate of adequacy regarding a draft environmental impact report, shall not be subject to the requirements of said ocean management plan.

SECTION 23. The secretary of energy and environmental affairs shall promulgate a final ocean management plan by December 31, 2009. Upon adoption, an ocean management plan shall formally be incorporated into the Massachusetts coastal zone management program, as referenced in section 4A of chapter 21A of the General Laws.

SECTION 24. Section 8 of this act shall take effect upon the adoption of an ocean management plan or by December 31, 2009, whichever occurs first.

SECTION 25. The secretary of energy and environmental affairs shall convene an advisory committee for the purpose of reviewing section 16 of chapter 132A of the General Laws and regulations promulgated pursuant thereto. The advisory committee shall review the regulatory definitions of “public necessity and convenience” and “significant alteration”. The secretary shall submit a report, together with legislative recommendations, if any, to the joint committee on environment, natural resources and agriculture by December 31, 2009.

Approved May 28 , 2008

B-293

Print

Acts 2008

CHAPTER 169 AN ACT RELATIVE TO GREEN COMMUNITIES.

Whereas, The deferred operation of this act would tend to defeat its purpose, which is to provide forthwith for renewable and alternative energy and energy efficiency in the commonwealth, therefore it is hereby declared to be an emergency law, necessary for the immediate preservation of the public convenience.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:

SECTION 1. Section 9A of chapter 7 of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by adding the following 4 paragraphs:-

When purchasing new motor vehicles, the commonwealth shall purchase hybrid or alternative fuel vehicles, as defined in section 1 of chapter 90, to the maximum extent feasible and consistent with the ability of such vehicles to perform their intended functions, at a rate of not less than 5 per cent annually for all new motor vehicle purchases so that, taking into account the existing number of such vehicles owned and operated by the commonwealth, not less than 50 per cent of the motor vehicles owned and operated by the commonwealth shall be hybrid or alternative fuel vehicles by the year 2018.

The division of operational services shall forward to the department of energy resources all requests for motor vehicle acquisitions by agencies of the commonwealth. The department of energy resources shall thereafter report to the division of operational services regarding the availability of a hybrid or alternative fuel vehicle that shall achieve the intended use designated by the requesting agency. The division of operational services, in consultation with the departments of energy resources and environmental protection, shall adopt a fuel efficiency standard for passenger vehicles owned or operated by the commonwealth.

The division of capital asset management and maintenance, in consultation with the department of energy resources, shall develop a system of protocols for the acquisition of alternative fuel vehicles and hybrids, including identifying the potential for acquisition of heavy, medium and light-duty vehicles, based on the anticipated mileage and usage of such vehicles, and the effectiveness of single-fuel or dual-fuel alternative fuel vehicles for the particular purpose identified.

The division of operational services, jointly with the department of energy resources, and the executive office of energy and environmental affairs shall submit to the secretary of administration and finance, the clerks of the senate and house of representatives and the joint committee on state

B-294

administration and regulatory oversight an annual statement on or before July 1 each year detailing the progress in meeting the requirements of this section. This report shall include the percentage of fuel used for the alternative fuel vehicles owned and operated by the commonwealth that qualifies as alternative fuel, as defined in section 1 of chapter 90, and the amount and cost of non-alternative fuel foregone as a consequence of the use of alternative fuel.

SECTION 2. Said chapter 7 is hereby further amended by inserting after section 39C the following section:-

Section 39D. (a) The commissioner shall require a state agency that initiates the construction of a new facility owned or operated by the commonwealth or a renovation of an existing facility owned or operated by the commonwealth when the renovation costs exceed $25,000 and includes the replacement of systems, components or other building elements which affect energy or water consumption to design and construct or renovate the facility in a manner that minimizes the life-cycle cost of the facility by utilizing energy efficiency, water conservation or renewable energy technologies under the following criteria:

(1) the state agency shall utilize alternate technologies when the life-cycle cost analysis conducted under subsection (b) shows that such systems are economically feasible;

(2) each new educational facility, including a municipal educational facility financed through the school building assistance program, for which the projected demand for hot water exceeds 1,000 gallons per day or which operates a heated swimming pool, shall be constructed, whenever economically and physically feasible, with a solar or other renewable energy system as the primary energy source for the domestic hot water system or swimming pool of the facility;

(3) the division of capital asset management and maintenance or the state agency shall, in the design, construction, equipping and operation of such facilities, coordinate these efforts with the department of energy resources in order to maximize reliance on, and the benefits of, renewable energy research and investment activities; and

(4) all higher education construction projects shall, at a minimum incorporate the MA-CHPS Green Schools Guidelines standards or an equivalent standard.

(b) The division of capital asset management and maintenance or the state agency initiating the construction or renovation of a facility as described in subsection (a) shall conduct a life-cycle cost analysis of any such facility’s proposed design that evaluates the short-term and long-term costs and the technical feasibility of using alternate technologies to provide lighting, heat, water heating, air conditioning, refrigeration, gas or electricity. In calculating life-cycle costs, a state agency shall include the value of avoiding carbon emissions, creating renewable energy certificates and other environmental and associated benefits created from the utilization of alternate technologies, as

B-295

applicable. This value shall be equal to the bid price of the published market value of any such benefit and shall increase or decrease at a projected rate determined by the department of energy resources. To calculate life-cycle costs, a state agency shall use a discount rate equal to the rate that the commonwealth's tax-exempt long-term bonds are yielding at the time of said calculation and shall assume that the cost of fossil fuels and electricity will increase at the rate of 3 per cent per year above the estimated rate of inflation or at a rate determined by the department of energy resources.

(c) Notwithstanding sections 11C and 11I of chapter 25A or any regulations issued thereunder, the division of capital asset management and maintenance may procure energy management services jointly with a state agency or a building authority that is procuring energy or related services. Said sections 11C and 11I shall apply to the extent feasible as determined by the commissioner of energy resources.

(d) For purposes of this section, the term "economically feasible" shall mean that the cost of installing and operating an alternate technology is lower than the cost of installing and operating the energy, energy-using technology or water-using technology that would otherwise be installed, as determined by a life-cycle cost analysis.

(e) The division of capital asset management and maintenance or the state agency initiating the construction or renovation of a facility subject to the requirements of subsection (a) shall file with the department of energy resources a report detailing the agency's compliance with this section with respect to each such facility.

(f) The department of energy resources shall issue an annual report to the general court detailing the compliance record of all state agencies with the construction and renovation provisions of this section.

SECTION 3. Chapter 10 of the General Laws is hereby amended by inserting after section 35HH the following section:-

Section 35II. There shall be established and set up on the books of the commonwealth a separate fund to be known as the RGGI Auction Trust Fund. The fund shall consist of amounts credited to the fund in accordance with section 22 of chapter 21A and expended exclusively for the purposes of said section 22 of said chapter 21A. The fund shall be administered by the commissioner of energy resources, subject to the approval of the secretary of energy and environmental affairs. The fund shall be an expendable trust fund and shall not be subject to appropriation or allotment. The commissioner shall report monthly by source all amounts credited to the fund and all expenditures by subsidiary made from the fund on the Massachusetts management and accounting reporting system. Amounts remaining in the fund at the end of a fiscal year shall not revert to the General Fund and shall be available for expenditure in the next fiscal year and thereafter.

B-296

SECTION 4. Chapter 12 of the General Laws is hereby amended by striking out section 11E, as appearing in the 2006 Official Edition, and inserting in place thereof the following section:-

Section 11E. (a) There shall be within the office of the attorney general, an office of ratepayer advocacy. The attorney general, through the office of ratepayer advocacy, may intervene, appear and participate in administrative, regulatory, or judicial proceedings on behalf of any group of consumers in connection with any matter involving rates, charges, prices and tariffs of an electric company, gas company, generator, transmission company, telephone company and telegraph company doing business in the commonwealth and subject to the jurisdiction of the department of public utilities or the department of telecommunications and cable. In addition, the attorney general may intervene, appear and participate in federal energy regulatory commission or other federal energy proceedings on behalf of ratepayers in the commonwealth.

The office of the ratepayer advocacy shall be under the direction of an assistant attorney general appointed under section 2. The assistant attorney general shall devote his full time and attention to the duties of the office.

For the purpose of such an intervention, appearance or participation, the attorney general may expend such funds as may be appropriated. These expenditures shall not exceed annually the amount assessed against such electric, gas, telephone and telegraph company under section 3 of chapter 24A, notwithstanding subsection (b). The attorney general shall not expend any of such funds if the expenditure shall conflict with his duties under section 3.

(b) In the performance of his duties under this section, the attorney general may retain an expert or a consultant to assist in proceedings before the department of public utilities or the department of telecommunications and cable. If the attorney general determines that the services of an expert or a consultant are necessary in a proceeding, he shall file notice in the proceeding that includes the type of expert or consultant sought and the anticipated cost. Upon the filing of such notice, the department before which the proceeding is commencing shall allow full parties to the proceeding the opportunity to comment regarding the necessity or desirability of such services. Absent a showing that the costs proposed are unnecessary for the attorney general to represent ratepayer interests in the proceeding or that such costs are not reasonable or proper, the use of the expert or consultant shall be approved. Costs for an expert or a consultant shall not exceed $150,000 per proceeding unless approved by the department based upon exigent circumstances, including the complexity of the proceeding. All reasonable and proper expenses, as defined in this section, shall be borne by the affected party in the proceeding and shall be paid by such party at such times and in such manner as the attorney general directs. All reasonable and proper costs and expenses, as defined in this section, shall be recognized by the departments for all purposes as proper business expenses of the affected party, recoverable through rates without further approval from the departments.

(c) The attorney general may request, orally or in writing, that any company subject to the

jurisdiction of the department of public utilities or the department of telecommunications and cable respond to not more than 15 information requests, including subparts, per calendar month regarding any matter related to the rates, charges, tariffs, books or service quality of the company, and the company shall answer these information requests fully and completely in a reasonably prompt manner, not to exceed 30 calendar days from the date of issuance, regarding any issue that is within the jurisdiction of the department. Department rules pertaining to the scope of questions and objections to discovery shall apply to any such request and the department shall have jurisdiction to rule on any objections or motions to compel. If the company fails to answer the information requests in a reasonably prompt manner, the attorney general may request enforcement of this subsection from the department having jurisdiction over the company.

SECTION 5. Chapter 13 of the General Laws is hereby amended by inserting after section 97 the following section:-

Section 97A. The board of registration of home inspectors, in consultation with the state board of building regulations and standards, the executive office of energy and environmental affairs and the energy efficiency advisory council, shall develop requirements and adopt regulations to require documents to be provided to a buyer of a single-family residential dwelling or a multiple-family residential dwelling with less than 5 dwelling units, or a condominium unit at the time of closing, outlining the procedures and benefits of a home energy audit; provided however, that no additional fees shall be imposed or collected in connection with the provision of such documents.

SECTION 6. Section 7 of chapter 21A of the General Laws, as so appearing, is hereby amended by striking out, in the first sentence, the word “division” and inserting in place thereof the following word:- department.

SECTION 7. Said chapter 21A is hereby further amended by adding the following 2 sections:-

Section 21. The secretary, in conjunction with the secretary of administration and finance, shall design and implement a bidding process for the competitive procurement of electric generation on behalf of any agency, executive office, department, board, commission, bureau, division or authority of the commonwealth procuring electricity from a local distribution company via basic service under section 1B of chapter 164. Any such competitive bid received shall include payment options with rates that remain uniform for a minimum period of 1 year. In lieu of designing and implementing a competitive bidding process as required by this section, the secretary may become a member of programs organized and administered by the Health and Educational Facilities Authority or its subsidiary organization for the purpose of such competitive group purchasing of electricity.

Section 22. (a) As used in this section, the following words shall have the following meanings, unless the context clearly requires otherwise:

B-298

“Allowance”, an authorization to emit a fixed amount of carbon dioxide.

“Cap and trade program”, a policy approach for controlling emissions from a group of emitting sources, such as electric generating stations, at a total cost that is expected to be lower than if sources were regulated individually by setting an overall cap or maximum amount of emissions from all regulated sources per compliance period that will achieve the desired environmental effects; provided, however, that a certain number of authorizations to emit in the form of emissions allowances shall be created, issued and made available to persons, companies, organizations or other entities through a sale by auction or direct allocation; and provided further that the total number of allowances made available in a compliance period shall not exceed the cap.

“Department”, department of environmental protection.

“RGGI” or “Regional Greenhouse Gas Initiative”, the Memorandum of Understanding dated December 20, 2005 , and any amendments thereto and the corresponding Model Rule and any amendments thereto that establishes a cap and trade program within the northeast region of the United States and other regions to the extent that the Memorandum of Understanding is amended.

(b) The department, in consultation with the department of energy resources, shall adopt rules and regulations establishing a carbon dioxide cap and trade program to limit and reduce the total carbon dioxide emissions released by electric generating stations that generate electric power. The rules and regulations shall comply with RGGI and permit the holders of carbon dioxide allowances to trade them in a regional market to be established through the RGGI.

(c)(1) The department shall provide, by regulation that all allowances issued under the program shall be offered for sale by auction. The proceeds recovered from the allowance auctions shall be deposited in the RGGI Auction Trust Fund established in section 35II of chapter 10. The proceeds shall be used without further appropriation for the following purposes only and shall be in a proportion to be determined by the department of energy resources with the approval of the secretary:

(i) to reimburse a municipality in which the property tax receipts, including, for the purposes of this clause, payments in lieu of taxes, are reduced as a result of the mandates of RGGI or the regulation of carbon dioxide emissions from electric generating stations; provided, however, that the amount of the payment shall be the difference between the amount of the tax receipts in the current tax year and the amount of the tax receipts in the year before implementation of RGGI; provided further, that no reimbursement shall be made if, in a tax year, the aggregate amount paid to a municipality by the owner of an electric generating station including, but not limited to, payments in lieu of taxes and property taxes, exceeds the aggregate amount paid to that municipality by that owner in the year before implementation of RGGI; and provided further, that payments from the fund shall be prioritized so that the first payments from the fund shall be made to municipalities under this clause;

B-299

(ii) to fund the green communities program established in section 10 of chapter 25A;

(iii) to provide zero interest loans to municipalities, which are not green communities under section 10 of chapter 25A for energy efficiency projects;

(iv) to promote energy efficiency, conservation and demand response; and

(v) to reimburse the commonwealth for costs associated with the administration of the cap and trade program.

(2) Notwithstanding this section, the department may set aside up to 1 per cent of the commonwealth's annual allocation of allowances to support the voluntary green power market which enables electricity consumers to support the development of renewable resources.

(d) The department of energy resources shall adopt regulations governing the auction of allowances. The department of energy resources may hire an independent contractor determined by the office to be qualified to conduct the auction in a manner that ensures the efficiency of the auction, or may provide for participation in a regional auction.

(e) The responsibilities created by establishing a carbon dioxide cap and trade program shall be in addition to any other responsibilities imposed by any other general or special law or rule or regulation and shall not diminish or reduce any power or authority of the department, including the authority to adopt standards and regulations necessary for the commonwealth to join and fully participate in a multistate program at any stage in the development and implementation of such a program intended to control emissions of carbon dioxide or other substances that are determined by the department to be damaging or altering the climate.

(f) Notwithstanding any general or special law or rule or regulation to the contrary, the state comptroller shall grant a permanent waiver or exemption from any applicable charges or assessments made against the proceeds from the auction of allowances under this section by the office of the comptroller under its authority under sections 5D of chapter 29.

(g) Notwithstanding any general or special law or regulation to the contrary, any information required by the department of energy resources or the department of any party participating in the cap and trade program, with the exception of any emission, offset and allowance tracking information required for compliance with the cap and trade program, shall be maintained for the sole and confidential use of the commonwealth, the department, the department of energy resources and their agents. This information shall not be deemed to be a public record as defined in clause Twenty-sixth of section 7 of chapter 4 and shall not be subject to demand for production under section 10 of chapter 66. Aggregates of such information may be prepared and such aggregates shall be public records. All information collected under this section may be shared with other states which afford such information

B-300
similar protection from public disclosure.

SECTION 8. Clause (ii) of subsection (a) of section 3D of chapter 23A of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by striking out, in line 50, the word “space.” and inserting in place thereof the following:- space;

(K) the area has been designated by the municipality as an area with potential for the development of a Class I renewable energy generating sources, as defined by section 11F of chapter 25A.

SECTION 9. Chapter 25 of the General Laws is hereby amended by inserting after section 5D the following section:-

Section 5E. The department may, from time to time, audit all companies subject to its jurisdiction, except steam distribution companies. Such audits may include, but shall not be limited to, review of the following documents: (a) all financial statements, the balance sheet, the income statement, the statement of cash flows, the statement of retained earnings, the notes to the financial statements, and the information in the annual return to the department; (b) all documents concerning reconciling mechanisms related to rates, prices, charges, or costs and savings related to a merger, acquisition or consolidation within 3 years after the merger, acquisition or consolidation; and (c) documents concerning service quality measure statistics and service quality performance at least every 3 years or whenever service quality penalties equal to or exceed 50 per cent of the maximum.

Upon written complaint of the attorney general requesting an independent audit of a company subject to the department’s jurisdiction, the department shall commence a proceeding within 30 days of receipt of the complaint for the purpose of ordering the requested audit in a reasonable time. The results of any audit so ordered shall be filed promptly with the department and each audit shall be paid for by the company that is the subject of the audit.

SECTION 10. Said chapter 25 is hereby further amended by inserting after section 18 the following section:-

Section 18A. The commission may make an assessment against each steam distribution company under the jurisdictional control of the department. Each steam distribution company shall annually report by March 31 its intrastate operating revenues for the previous calendar year to the department. The assessments shall be apportioned according to each steam distribution company’s intrastate operating revenues, to produce an annual amount not greater than $600,000, as shall be determined and certified annually by the commission as sufficient to reimburse the commonwealth for funds appropriated by the general court for the operation and general administration of the department and for the cost of fringe benefits as established by the commissioner of administration under section 5D of chapter 29, including group life and health insurance, retirement benefits, paid vacations,

B-301

holidays and sick leave.

Each company shall pay the amount assessed against it within 30 days after receipt of the notice of assessment from the department. Such assessments collected by the department shall be credited to the General Fund. Any funds unexpended in any fiscal year for the purposes for which such assessments were made shall be credited against the assessment to be made in the following fiscal year and the assessment in the following fiscal year shall be reduced by any such unexpended amount.

SECTION 11. Said chapter 25 is hereby further amended by striking out sections 19 and 20, as appearing in the 2006 Official Edition, and inserting in place thereof the following 4 sections:-

Section 19. (a) The department shall require a mandatory charge of 2.5 mills per kilowatt-hour for all consumers, except those served by a municipal lighting plant, to fund energy efficiency programs including, but not limited to, demand side management programs. The programs shall be administered by the electric distribution companies and by municipal aggregators with energy plans certified by the department under subsection (b) of section 134 of chapter 164. In addition to the aforementioned mandatory charge, such programs shall also be funded, without further appropriation, by: (1) amounts generated by the distribution companies and municipal aggregators under the Forward Capacity Market program administered by ISO -NE, as defined in section 1 of chapter 164; and (2) cap and trade pollution control programs, including, but not limited to, and subject to section 22 of chapter 21A, not less than 80 per cent of amounts generated by the carbon dioxide allowance trading mechanism established under the Regional Greenhouse Gas Initiative Memorandum of Understanding, as defined in subsection (a) of section 22 of chapter 21A, and the NOx Allowance Trading Program; and (3) other funding as approved by the department after consideration of: (i) the effect of any rate increases on residential and commercial consumers; (ii) the availability of other private or public funds, utility administered or otherwise, that may be available for energy efficiency or demand resources; and (iii) whether past programs have lowered the cost of electricity to residential and commercial consumers. In authorizing such programs, the department shall ensure that they are delivered in a cost-effective manner capturing all available efficiency opportunities, minimizing administrative costs to the fullest extent practicable and utilizing competitive procurement processes to the fullest extent practicable.

(b) The department may approve and fund gas energy efficiency programs proposed by gas distribution companies including, but not limited to, demand side management programs. Energy efficiency activities eligible for funding under this section shall include combined heat and power and geothermal heating and cooling projects. Funding may be supplemented by funds authorized by section 21. The programs shall be administered by the gas distribution companies. In authorizing such programs, the department shall ensure that they are delivered in a cost-effective manner capturing all available efficiency opportunities, minimizing administrative costs to the fullest extent practicable and utilizing competitive procurement processes to the fullest extent practicable.

B-302

(c) Electric and gas energy efficiency program funds shall be allocated to customer classes, including the low-income residential subclass, in proportion to their contributions to those funds; provided, however, that at least 10 per cent of the amount expended for electric energy efficiency programs and at least 20 per cent of the amount expended for gas energy efficiency programs shall be spent on comprehensive low-income residential demand side management and education programs. The low-income residential demand side management and education programs shall be implemented through the low-income weatherization and fuel assistance program network and shall be coordinated with all electric and gas distribution companies in the commonwealth with the objective of standardizing implementation. Such programs shall be screened only through cost-effectiveness testing which compares the value of program benefits to program costs to ensure that a program is designed to obtain energy savings and system benefits with value greater than the costs of the program.

Section 20. (a) The department shall require a mandatory charge of 0.5 mill per kilowatt-hour for all electricity consumers, except those served by a municipal lighting plant which does not supply generation service outside its own service territory or does not open its service territory to competition at the retail level, to support the development and promotion of renewable energy projects. All revenues generated by the mandatory charge shall be deposited into the Massachusetts Renewable Energy Trust Fund, established under section 4E of chapter 40J.

(b) Notwithstanding any general or special law to the contrary: (1) a municipal lighting plant which does not supply generation service outside its own service territory or does not open its service territory to competition may elect to assess and remit a mandatory charge per kilowatt-hour upon its electricity consumers on the same terms and conditions as apply to the charge imposed on consumers residing in competitive distribution service territories under this section; provided, however, that such an election by a municipal lighting plant shall be irrevocable and such a municipal lighting plant shall not be deemed to be supplying generation service outside its service territory or opening its service territory to competition at the retail level for the purposes of the first sentence of subsection (a); and (2) in administering the Massachusetts Renewable Energy Trust Fund, the Massachusetts Technology Park Corporation, doing business as the Massachusetts Technology Collaborative, or the governing board, as applicable, shall not make any grant or loan or provide any subsidy from the trust fund to any municipal lighting plant or consumer residing in the distribution service territory of such municipal lighting plant unless: (A) a mandatory charge per kilowatt-hour is assessed against all consumers residing in the distribution service territory and remitted to the collaborative under the first sentence of subsection (a) or clause (1); or (B) the board of directors of the collaborative, as a condition precedent to any such grant, loan or subsidy, shall have determined and incorporated into the minutes of its proceedings findings that: (i) any such grant, loan or subsidy is intended for the principal purpose of generating public benefits for those consumers who reside in distribution service territories in which the mandatory charge is so imposed and remitted and will generate only incidental private benefits to the recipient or others residing in a distribution service territory in which the mandatory charge is not so imposed and remitted; and (ii) the facts and circumstances associated

B-303

with the recipient or the residence of the recipient provide unique or extraordinary opportunities to advance the public purposes of the trust fund over those opportunities available through grants or subsidies made to recipients residing in distribution service territories in which such a mandatory charge is assessed and remitted.

Section 21. (a) To mitigate capacity and energy costs for all customers, the department shall ensure that, subject to subsection (c) of section 19, electric and natural gas resource needs shall first be met through all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply. The cost of supply shall be determined by the department with consideration of the average cost of generation to all customer classes over the previous 24 months.

(b)(1) Every 3 years, on or before April 30, the electric distribution companies and municipal aggregators with certified efficiency plans shall jointly prepare an electric efficiency investment plan and the natural gas distribution companies shall jointly prepare a natural gas efficiency investment plan. Each plan shall provide for the acquisition of all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply and shall be prepared in coordination with the energy efficiency advisory council established by section 22. Each plan shall provide for the acquisition, with the lowest reasonable customer contribution, of all of the cost effective energy efficiency and demand reduction resources that are available from municipalities and other governmental bodies.

(2) A plan shall include: (i) an assessment of the estimated lifetime cost, reliability and magnitude of all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply; (ii) the amount of demand resources, including efficiency, conservation, demand response and load management, that are proposed to be acquired under the plan and the basis for this determination; (iii) the estimated energy cost savings that the acquisition of such resources will provide to electricity and natural gas consumers, including, but not limited to, reductions in capacity and energy costs and increases in rate stability and affordability for low-income customers; (iv) a description of programs, which may include, but which shall not be limited to: (A) efficiency and load management programs; (B) demand response programs; (C) programs for research, development and commercialization of products or processes which are more energy-efficient than those generally available; (D) programs for development of markets for such products and processes, including recommendations for new appliance and product efficiency standards; (E) programs providing support for energy use assessment, real time monitoring systems, engineering studies and services related to new construction or major building renovation, including integration of such assessments, systems, studies and services with building energy codes programs and processes, or those regarding the development of high performance or sustainable buildings that exceed code; (F) programs for the design, manufacture, commercialization and purchase of energy-efficient appliances and heating, air conditioning and lighting devices; (G) programs for planning and evaluation; (H) programs providing commercial, industrial and institutional customers with greater flexibility and control over demand side investments funded by the programs at their facilities; and (I) programs for

B-304

public education regarding energy efficiency and demand management; provided, however, that not more than 1 per cent of the fund shall be expended for items (C) and (D) collectively, without authorization from the advisory council; (v) a proposed mechanism which provides performance incentives to the companies based on their success in meeting or exceeding the goals in the plan; (vi) the budget that is needed to support the programs; (vii) a fully reconciling funding mechanism which may include, but which shall not be limited to, the charge authorized by section 19; (viii) the estimated amount of reduction in peak load that will be reduced from each option and any estimated economic benefits for such projects, including job retention, job growth or economic development; and (ix) data showing the percentage of all monies collected that will be used for direct consumer benefit, such as incentives and technical assistance to carry the plan. With the approval of the council, the plan may also include a mechanism to prioritize projects that have substantial benefits in reducing peak load, reducing the energy consumption or costs of municipalities or other governmental bodies, or that have economic development, job creation or job retention benefits.

(3) A program included in the plan shall be screened through cost-effectiveness testing which compares the value of program benefits to the program costs to ensure that the program is designed to obtain energy savings and system benefits with value greater than the costs of the program. Program cost effectiveness shall be reviewed periodically by the department and by the energy efficiency advisory council. If a program fails the cost-effectiveness test as part of the review process, it shall either be modified to meet the test or shall be terminated.

(c) Each plan prepared under subsection (b) shall be submitted for approval and comment by the energy efficiency advisory council every 3 years on or before April 30. The electric and natural gas distribution companies and municipal aggregators shall provide any additional information requested by the council that is relevant to the consideration of the plan. The council shall review the plan and any additional information and shall submit its approval or comments to the electric and natural gas distribution companies and municipal aggregators not later than 3 months after submission of the plan. The electric and natural gas distribution companies and municipal aggregators may make any changes or revisions to reflect the input of the council.

(d)(1) The electric and natural gas distribution companies and municipal aggregators shall submit their respective plans, together with the council’s approval or comments and a statement of any unresolved issues, to the department every 3 years on or before October 31. The department shall consider the plans and shall provide an opportunity for interested parties to be heard in a public hearing.

(2) Not later than 90 days after submission of a plan, the department shall issue a decision on the plan which ensures that the electric and natural gas distribution companies have identified and shall capture all energy efficiency and demand reduction resources that are cost effective or less expensive than supply and shall approve, modify and approve, or reject and require the resubmission of the plan accordingly. The department shall approve a fully reconciling funding mechanism for the

approved plan and, in the case of municipal aggregators, a fully reconciling funding mechanism that requires coordination between the distribution company and municipal aggregator to ensure that program costs are collected, allocated and distributed in a cost effective, fair and equitable manner. The department shall determine the effectiveness of the plan on an annual basis.

(3) Each electric and natural gas plan shall be in effect for 3 years.

(e) If an electric or natural gas distribution company or municipal aggregator has not reasonably complied with the plan, the department may open an investigation. In any such investigation, the utility company or aggregator shall have the burden of proof to show whether it had good cause for failing to reasonably comply with the plan. If the utility company or aggregator does not meet its burden, the department may levy a fine of not more than the product of $0.05 per kilowatt-hour or $1 per therm times the shortfall of kilowatt-hours saved or therms saved, as applicable, depending upon the facts and circumstances and degree of fault, which shall be paid to the Massachusetts Technology Park Corporation within 60 days after the end of the year in which the department levies the fine. The fine shall not impact ratepayers. The department of energy resources shall oversee the use of the funds held by the Massachusetts Technology Park Corporation under this subsection so as to maximize the amount of energy efficiency achieved.

Section 22. (a) The department shall appoint and convene an energy efficiency advisory council which shall consist of 11 members, including 1 person representing each of the following: (1) residential consumers, (2) the low-income weatherization and fuel assistance program network, (3) the environmental community, (4) businesses, including large C&I end-users, (5) the manufacturing industry, (6) energy efficiency experts, (7) organized labor, (8) the department of environmental protection, (9) the attorney general, (10) the executive office of housing and economic development, and (11) the department of energy resources. Interested parties shall apply to the department for designation as members. Members shall serve for terms of 5 years and may be reappointed. The commissioner of energy resources shall serve as chair of the council. A member who is a representative of energy efficiency experts shall not have a contractual relationship with an electric or natural gas distribution company doing business in the commonwealth or any affiliate of such company, or any municipal aggregator. There shall be 1 non-voting, ex-officio member from each of the electric and natural gas distribution companies, 1 from each of the approved municipal aggregators, 1 from the heating oil industry and 1 from energy efficiency businesses.

(b) The council shall, as part of the approval process by the department, seek to maximize net economic benefits through energy efficiency and load management resources and to achieve energy, capacity, climate and environmental goals through a sustained and integrated statewide energy efficiency effort. The council shall review and approve demand resource program plans and budgets, work with program administrators in preparing energy resource assessments, determine the economic, system reliability, climate and air quality benefits of efficiency and load management resources, conduct and recommend relevant research, and recommend long term efficiency and load

management goals to maximize economic savings and achieve environmental goals. Approval of efficiency and demand resource plans and budgets shall require a two-thirds majority vote. The council shall, as part of its review of plans, examine opportunities to offer joint programs providing similar efficiency measures that save more than 1 fuel resource or to coordinate programs targeted at saving more than one fuel resource. Any costs for joint programs shall be allocated equitably among the efficiency programs.

(c) The council may retain expert consultants; provided, however, that such consultants shall not have any contractual relationship with an electric or natural gas distribution company doing business in the commonwealth or any affiliate of such company.

The council shall annually submit to the department a proposal regarding the level of funding required for the retention of expert consultants and reasonable administrative costs. The proposal shall be approved by the department either as submitted or as modified by the department. The department shall allocate funds sufficient for these purposes from the natural gas and electric efficiency funding authorized under section 19; provided, however, that such allocation shall not exceed 1 per cent of such funding on an annual basis. The consultants used under this section shall be experts in energy efficiency and shall be independent.

(d) The electric and natural gas distribution companies and municipal aggregators shall provide quarterly reports to the council on the implementation of their respective plans. The reports shall include a description of the program administrator's progress in implementing the plan, a summary of the savings secured to date and such other information as the council shall determine. The council shall provide an annual report to the department and the joint committee on telecommunications, utilities and energy on the implementation of the plan which includes descriptions of the programs, expenditures, cost-effectiveness and savings and other benefits during the previous year.

SECTION 12. Chapter 25A of the General Laws, as so appearing, is hereby amended by striking out sections 1 to 3, inclusive, as amended by section 28 of chapter 19 of the acts of 2007, and inserting in place thereof the following 3 sections:-

Section 1. There shall be within the executive office of energy and environmental affairs a department called the department of energy resources, under the supervision of a commissioner of energy resources, hereinafter the commissioner. The duties given to the commissioner in this chapter and in any other general or special law shall be exercised and discharged subject to the direction, control and supervision of the secretary of energy and environmental affairs. The commissioner shall be appointed by the secretary of energy and environmental affairs, with the approval of the governor, and may, with like approval, be removed. The commissioner shall be a person of skill and experience in the field of energy regulation or policy and shall serve a term coterminous with that of the governor. The position of commissioner shall be classified in accordance with section 45 of chapter 30 and the salary shall be determined in accordance with section 46C of said chapter 30. The commissioner shall

B-307

devote full time during business hours to the duties of the office. In the case of an absence or vacancy in the office of the commissioner, or in the case of disability as determined by the secretary, the secretary may designate an acting commissioner to serve as commissioner until the vacancy is filled or the absence or disability ceases. The acting commissioner shall have all the powers and duties of the commissioner and shall have similar qualifications as the commissioner.

Section 2. The commissioner shall be the executive and administrative head of the department of energy resources and shall be responsible for administering and enforcing the provisions of law relative to the division and to each administrative unit thereof.

There shall be within the department 3 divisions: (i) a division of energy efficiency, which shall work with the department of public utilities regarding energy efficiency programs; (ii) a division of renewable and alternative energy development, which shall oversee and coordinate activities that seek to maximize the installation of renewable and alternative energy generating sources that will provide benefits to ratepayers, advance the production and use of biofuels and other alternative fuels as the division may define by regulation, and administer the renewable portfolio standard and the alternative portfolio standard; and (iii) a division of green communities, which shall serve as the principal point of contact for municipalities and other governmental bodies concerning all matters under the jurisdiction of the department of energy resources. Each division shall be headed by a director who shall be appointed by the commissioner and who shall be a person of skill and experience in the field of energy efficiency, renewable energy or alternative energy, and energy regulation or policy, respectively. The directors shall be the executive and administrative heads of their respective divisions and shall be responsible for administering and enforcing the law relative to such division and to each administrative unit thereof under the supervision, direction and control of the commissioner. The directors shall serve at the pleasure of the commissioner, shall receive such salary as may be determined by law and shall devote full time during business hours to the duties of the office. In the case of an absence or vacancy in the office of the director, or in the case of disability as determined by the commissioner, the commissioner may designate an active director to serve as director until the vacancy is filled or the absence or disability ceases. The acting director shall have all the powers and duties of the director and shall have similar qualifications as the director.

The commissioner may, from time to time, subject to appropriation, establish within the department such administrative units as may be necessary for the efficient and economical administration of the department and, when necessary for such purpose, may abolish any such administrative unit, or may merge any 2 or more of them, as the commissioner deems advisable. The commissioner shall prepare and keep current a statement of the organization of the department, of the assignment of its functions to its various administrative units, offices and employees, and of the places at which and the methods whereby the public may receive information or make requests. Such statement shall be known as the department’s description of organization. A current copy of the description of organization shall be kept on file in the office of the secretary of state and in the office of the secretary of administration.

B-308

Section 3. For the purposes of this chapter the following words shall have the following meanings:-

“Alternative energy development”, shall include but not be limited to solar energy, wood, alcohol, hydroelectric, biomass energy systems, renewable non-depletable and recyclable energy sources.

“Alternative energy property”, any property powered in whole or in part by the sun, wind, water, biomass, alcohol, wood, or any renewable, non-depletable or recyclable fuel, and property related to the exploration, development, processing, transportation and distribution of the aforementioned energy resources.

“Building authority”, the University of Massachusetts Building Authority , the State College Building Authority or any other building authority which may be established for similar purposes.

“Commissioner”, the commissioner of energy resources.

“Department”, the department of energy resources.

“Eligible”, able to meet all requirements for offerors or bidders set forth in section 11C or 11I and section 44D of chapter 149 and not barred from bidding under section 44C of said chapter 149 or any other applicable law, and who shall certify that he is able to furnish labor that can work in harmony with all other elements of labor employed or to be employed on the work.

“End-user”, any individual, corporation, firm or subsidiary of any firm that is an ultimate consumer of petroleum products and which, as part of its normal business practices, purchases or obtains petroleum products from a wholesaler or reseller and receives delivery of that product.

“Energy audit”, a determination of the energy consumption characteristics of a building or facility which: (a) identifies the type, size and rate of energy consumption of such building or facility and the major energy using systems of such building or facility; (b) determines appropriate energy conservation maintenance and operating procedures; and (c) indicates the need, if any, for the acquisition and installation of energy conservation measures or alternative energy property.

“Energy conservation”, shall include but not be limited to the modification of or change in the operation of real or personal property in a manner likely to improve the efficiency of energy use, and shall include energy conservation measures and any process to audit or identify and specify energy and cost savings.

“Energy conservation measures”, measures involving modifications of maintenance and operating procedures of a building or facility and installations therein, which are designed to reduce energy consumption in such building or facility, or the installation or modification of an installation in a

B-309
building or facility which is primarily intended to reduce energy consumption.

“Energy conservation projects”, projects to promote energy conservation, including but not limited to energy conserving modification to windows and doors; caulking and weatherstripping; insulation, automatic energy control systems; hot water systems; equipment required to operate variable steam, hydraulic and ventilating systems; plant and distribution system modifications, including replacement of burners, furnaces or boilers; devices for modifying fuel openings; electrical or mechanical furnace ignition systems; utility plant system conversions; replacement or modification of lighting fixtures; energy recovery systems; on-site electrical generation equipment using new renewable generating sources as defined in section 11F; and cogeneration systems.

“Energy management services”, a program of services, including energy audits, energy conservation measures, energy conservation projects or a combination thereof, and building maintenance and financing services, primarily intended to reduce the cost of energy and water in operating buildings, which may be paid for, in whole or in part, by cost savings attributable to a reduction in energy and water consumption which result from such services.

“Energy savings”, a measured reduction in fuel, energy, operating or maintenance costs resulting from the implementation of energy conservation measures or projects; provided, however, that any payback analysis to evaluate the energy savings of a geothermal energy system to provide heating, cooling or water heating over its expected lifespan shall include gas and electric consumption savings, maintenance savings and shall use an average escalation rate based on the most recent information for gas and electric rates compiled by the Energy Information Administration of the United States Department of Energy.

“Local governmental body”, a city, town, district, regional school district or county, or an agency or authority thereof, including a housing authority, board, commission, department or instrumentality of a city, town district, regional school district or county, and any other agency which is not a state agency or building authority; or a combination of 2 or more such cities, towns, districts, regional school districts or counties, or agencies or authorities thereof.

“Marine or hydrokinetic energy”, electrical energy from: (a) waves, tides and currents in oceans, estuaries and tidal areas; (b) free-flowing water in rivers, lakes and streams; (c) free-flowing water in man-made channels; or (d) differentials in ocean temperature, called ocean thermal energy conversion.

“Minor informalities”, minor deviations, insignificant mistakes and matters of form rather than substance of the proposal or contract document which may be waived or corrected without prejudice to other offerors, potential offerors or the public agency.

“Non-renewable energy supply and resource development”, shall include but not be limited to

B-310

gasoline, natural gas, coal, nuclear energy, offshore and onshore petroleum, and facilities related to the exploration, development, processing, transportation and distribution of such resources and programs established for the allocation of supplies of such resources and the development of supply shortage contingency plans.

"Person", any natural person, business, partnership, corporation, union, committee, club, or other organization, entity or group of individuals.

"Petroleum products", propane, gasoline, unleaded gasoline, kerosene, #2 heating oil, diesel fuel, kerosene base jet fuel, and #4, 5, and 6 residual oil for utility and non-utility uses, and all petroleum derivatives, whether in bond or not, which are commonly burned to produce heat, power, electricity or motion or which are commonly processed to produce synthetic gas for burning.

"Qualified provider", responsible and eligible person able to meet all requirements set forth in section 11C or 11I, and not barred from bidding under section 44C of chapter 149 or any other applicable law and experienced in the design, implementation and installation of energy savings measures.

"Reseller", any person, corporation, firm or subsidiary of any firm that carries on the trade or business of purchasing petroleum products and reselling them without substantially changing their form or any wholesaler or retail seller of electricity or natural gas.

"Responsible", demonstrably possessing the skill, ability and integrity necessary to faithfully perform the work required by a particular contract, based upon a determination of competent workmanship and financial soundness in accordance with section 11C or 11I and section 44D of chapter 149.

"Responsive offeror", a person who has submitted a proposal which conforms in all respects to the requests for proposals.

"State agency", any agency, authority, board, bureau, commission, committee, council, department, division, institution, officer or other agency of the commonwealth, including quasi-public agencies.

"Wholesaler", any person, corporation, firm or any part or subsidiary of any firm which supplies, sells, transfers or otherwise furnishes petroleum products to resellers or end-users.

SECTION 13. Section 5 of said chapter 25A, as appearing in the 2006 Official Edition, is hereby amended by striking out the first sentence and inserting in place thereof the following sentence:- The commissioner shall file an annual report with the clerks of the senate and the house of representatives, the joint committee on telecommunications, utilities and energy and the senate and

B-311

house committees on ways and means: (a) listing the number of employees of the department of energy resources, the salaries and titles of each employee, the source of funding for the salaries of said employees and the projected date when federal funds for such positions are expected to terminate; (b) listing and describing grant programs of the department funded by the federal government, including the amount of funding by grant; (c) listing and describing other programs of the department, including the amount and source of funding by program; and (d) describing the energy audit, energy conservation and alternative energy bond programs by categories of projects, prospective grantees under each category, if known, and amounts to be spent by category and grantee.

SECTION 14. Section 6 of said chapter 25A, as so appearing, is hereby amended by striking out, in line 1, the words “division of energy resources” and inserting in place thereof the following word:- department.

SECTION 15. Said section 6 of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 38, the words “telecommunications and energy” and inserting in place thereof the following words:- public utilities.

SECTION 16. Section 7 of said chapter 25A, as so appearing, is hereby amended by striking out, in lines 1, in lines 21 and 22, and in line 29, the words “division of energy resources” and inserting in place thereof, in each instance, the following word:- department.

SECTION 17. Said section 7 of said chapter 25A, as so appearing, is hereby further amended by striking out, in lines 8, 22, 30, 32, 39, 49 and 50 the word “division” each time it appears, and inserting in place thereof the following word:- department.

SECTION 18. Said section 7 of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 40, the words “telecommunications and energy” and inserting in place thereof the following words:- public utilities.

SECTION 19. Section 8 of said chapter 25A, as so appearing, is hereby amended by striking out, in line 12, the words “division of energy resources” and inserting in place thereof the following word:- department.

SECTION 20. Section 9 of said chapter 25A, as so appearing, is hereby amended by striking out, in line 2, the words “of energy resources”.

SECTION 21. Said section 9 of said chapter 25A, as so appearing, is hereby amended by striking out, in lines 9 and 10, the words “division of energy resources” and inserting in place thereof the following word:- department.

B-312

SECTION 22. Said chapter 25A is hereby amended by striking out section 10, as so appearing, and inserting in place thereof the following 2 sections:-

Section 10. (a) The division of green communities shall assist the commonwealth's municipalities and other local governmental bodies to: reduce energy consumption and costs, reduce pollution, facilitate the development of renewable and alternative energy resources, and create local jobs related to the building of renewable and alternative energy facilities and the installation of energy-efficient equipment. The director of the division shall be responsible for the administration and oversight of the green communities program and shall apply and disburse monies and revenues as provided in this section.

(b) The division shall establish a green communities program. The purpose of the program shall be to provide technical and financial assistance, in the form of grants and loans, to municipalities and other local governmental bodies that qualify as green communities under this section. These loans and grants shall be used to finance all or a portion of the costs of studying, designing, constructing and implementing energy efficiency activities, including but not limited to, energy conservation measures and projects; procurement of energy management services; installation of energy management systems; adoption of demand side reduction initiatives; and the adoption of energy efficiency policies. They shall also be used to finance the siting and construction of renewable and alternative energy projects on municipally-owned land.

(c) To qualify as a green community, a municipality or other local governmental body shall: (1) file an application with the division in a form and manner to be prescribed by the division; (2) provide for the as-of-right siting of renewable or alternative energy generating facilities, renewable or alternative energy research and development facilities, or renewable or alternative energy manufacturing facilities in designated locations; (3) adopt an expedited application and permitting process under which these energy facilities may be sited within the municipality and which shall not exceed 1 year from the date of initial application to the date of final approval; (4) establish an energy use baseline inventory for municipal buildings, vehicles and street and traffic lighting, and put in place a comprehensive program designed to reduce this baseline by 20 per cent within 5 years of initial participation in the program; (5) purchase only fuel-efficient vehicles for municipal use whenever such vehicles are commercially available and practicable; and (6) require all new residential construction over 3,000 square feet and all new commercial and industrial real estate construction to minimize, to the extent feasible, the life-cycle cost of the facility by utilizing energy efficiency, water conservation and other renewable or alternative energy technologies. The secretary may waive these requirements based on a written finding that due to unusual circumstances, a municipality cannot reasonably meet all of the requirements and the municipality has committed to alternative measures that advance the purposes of the green communities program as effectively as adherence to the requirements.

B-313

(d) Funding for the green communities program in any single fiscal year shall be available, without the need for further appropriation, in a total amount of not more than $10 million from: (1) monies generated by all cap and trade pollution control programs, including, but not limited to, the cap and trade program established under the NOx Allowance Trading Program and the carbon dioxide allowance trading mechanism established under the Regional Greenhouse Gas Initiative, as defined in subsection (a) of section 22 of chapter 164; (2) such amounts as may be directed to municipalities or other governmental bodies under section 19 of chapter 25; (3) amounts from alternative compliance payments established and administered under 225 CMR 14.00 adopted under section 11F; and (4) other funds as the governing board of the Massachusetts Renewable Energy Trust Fund established under section 4E of chapter 40J, may provide.

(e) The division shall adopt rules, regulations and guidelines for the administration and enforcement of this section, including, but not limited to, establishing applicant criteria, funding priority, application forms and procedures, and energy efficiency product requirements. The division shall also adopt regulations providing for a separate green communities program for those communities served by municipal lighting plants that have chosen to adopt the renewable energy charge under section 20 of chapter 25.

(f) The division shall annually, not later than April 1, submit a report to the clerks of the senate and the house of representatives, the joint committee on telecommunications, utilities and energy, the joint committee on state administration and regulatory oversight, and the senate and house committees on ways and means detailing the expenditures and results relative to the green communities program.

Section 10A. The division shall design and implement a competitive bidding procedure for the procurement of electric generation from renewable and alternative generating facilities on behalf of municipalities certified as green communities under section 10. Any competitive bids received shall include payment options with rates that remain uniform for a minimum of 5 years. In lieu of designing and implementing a competitive bidding process as required by this section, the director may become a member of programs organized and administered by the Health and Educational Facilities Authority or its subsidiary organization for the purpose of such competitive group purchasing of electricity.

SECTION 23. Said chapter 25A is hereby further amended by striking out section 11C, as so appearing, and inserting in place thereof the following section:-

Section 11C. (a) A state agency or building authority may, in the manner provided by this section, contract for the procurement of energy management services. Such contracts may include terms of not more than 20 years. The state agency or building authority shall solicit competitive sealed proposals through a request for proposals. At least 1 week prior to soliciting proposals for a contract under this section, the agency or authority shall notify the commissioner in writing, in such form and including such information as the commissioner shall prescribe by regulation, of the intent to solicit

proposals. Such notification shall, at a minimum, include a complete copy of the request for proposals. An acknowledgment of receipt, in such form and including such information as the commissioner shall prescribe by regulation, shall be issued to the state agency or building authority upon successful compliance with the requirements of this paragraph.

Requests for proposals for an energy management services contract to be entered into on behalf of a state agency or a building authority, except a quasi-public agency, shall be developed jointly by the division of capital asset management and maintenance and the using agency. Such proposals shall only be solicited by the division of capital asset management and maintenance after the commissioner of the division has given prior written approval, and no contract for energy management services shall be valid unless approved and signed by that commissioner. A quasi-public agency may develop a request for proposal and enter into a contract for energy management services independently. The commissioner of capital asset management and maintenance may delegate to state agencies and building authorities the authority to enter into such contracts with an estimated construction cost of less than $1 million. The delegation shall be in writing from the commissioner to the using agency or building authority.

The request for proposals published by a state agency or building authority shall include: (1) the time and date for receipt of proposals and the address of the office to which the proposals shall be delivered; (2) a description of the services to be procured, including specific requirements and all evaluation criteria that will be utilized by the state agency or building authority; and (3) proposed contract terms and conditions and an identification of such terms and conditions which shall be deemed mandatory and non-negotiable. The request for proposals may incorporate documents by reference, provided that the request for proposals specifies where prospective offerors may obtain the documents. The state agency or building authority shall make copies of the request for proposals available to all persons on an equal basis. Public notice of the request for proposals shall conform to the procedures set forth in subsection (1) of section 44J of chapter 149. Proposals shall be opened publicly, in the presence of 2 or more witnesses, at the time specified in the request for proposals, and shall be available for public inspection.

Sections 44A, 44B and 44E through 44H, inclusive, of chapter 149 shall not apply to contracts procured under this section. Section 44D of chapter 149 shall apply as appropriate to proposals submitted for contracts under this section, and every such proposal shall be accompanied by: (1) a copy of a certificate of eligibility issued by the commissioner of the division of capital asset management and maintenance; and (2) an update statement. The offeror’s qualifications shall be evaluated by the division of capital asset management and maintenance in a manner designated by the commissioner of that division. If the state agency or building authority determines that any offeror is not responsible or eligible, the agency or authority shall reject the offeror, and shall give written notice of such action to the division of capital asset management and maintenance.

State agencies and building authorities shall award contracts under this section to the lowest

B-315

offeror demonstrably possessing the skill, ability and integrity necessary to perform faithfully energy management services.

Payments under a contract for energy management services may be based in whole or in part on any cost savings attributable to a reduction in energy and water consumption due to the contractor's performance or revenues gained due to the contractor's services which are aimed at energy and water cost savings.

(b) A local governmental body may, in the manner provided in this subsection, contract for the procurement of energy management services. Unless no other manner of description suffices, and the local governmental body so determines in writing, setting forth the basis for the determination, all requirements shall be written in a manner which describes the requirements to be met without having the effect of exclusively requiring a proprietary supply or service, or a procurement from a sole source.

Subject to a local governmental body's authority to reject, in whole or in part, any and all proposals, as provided in this section, a local governmental body shall unconditionally accept a proposal without alteration or correction, except as provided in this paragraph. An offeror may correct, modify or withdraw a proposal by written notice received in the office designated in the request for proposals prior to the time and date set for opening the proposals. After proposal opening, an offeror may not change any provisions of the proposal in a manner prejudicial to the interests of the local governmental body or fair competition. The local governmental body shall waive minor informalities or allow the offeror to correct them. If a mistake and the intended meaning of the proposal are clearly evident on the face of the proposal document, the local governmental body shall correct the mistake to reflect the intended meaning and so notify the offeror in writing, and the offeror may not withdraw the proposal. An offeror may withdraw a proposal if a mistake is clearly evident on the face of the proposal but the intended meaning is not similarly evident.

The local governmental body shall evaluate each proposal and award each contract based solely on the criteria set forth in the request for proposals. Such criteria shall include, but not be limited to, all standards by which the local governmental body shall evaluate responsiveness, responsibility, qualifications of the offeror, technical merit and cost to the local governmental body. The request for proposals shall specify the method for comparing proposals to determine the proposal offering the lowest overall cost to the local governmental body, taking into consideration comprehensiveness of services, energy or water cost savings, costs to be paid by the local governmental body, and revenues to be paid to the local governmental body. If the local governmental body awards the contract to an offeror who did not submit the proposal offering the lowest overall cost, the governmental body shall explain the reason for the award in writing.

The evaluations shall specify revisions, if needed, to each proposal which should be obtained by negotiation before the contract shall be awarded to the offeror of the proposal. The local governmental body may condition an award on successful negotiation of the revisions specified in the evaluation and

shall explain in writing the reasons for omitting any such revision from a plan incorporated by reference in the contract.

(c) The state agency, building authority or local governmental body may cancel a request for proposals or may reject in whole or in part any and all proposals when the state agency, building authority or local governmental body determines that cancellation or rejection serves the best interests of the state agency, building authority or local governmental body. The state agency, building authority or local governmental body shall state in writing the reason for a cancellation or rejection. The state agency, building authority or local governmental body shall promptly publish in the central register notice of the offeror awarded the contract. The state agency, building authority or local governmental body shall, within 30 days, file a copy of the contract with the commissioner.

The commissioner, in consultation with the commissioner of capital asset management and maintenance, shall adopt regulations for the procurement of energy management services under this section for local government bodies. The commissioner of capital asset management and maintenance shall adopt regulations for services to be procured for state agencies and building authorities, and shall adopt regulations, in consultation with the director of housing and community development, for the operations of housing authorities. Such regulations may limit the scope of services procured and the duration of contracts, and shall include any requirements that the commissioner or the commissioner of capital asset management and maintenance deems necessary to promote prudent management of such contracts at the appropriate facilities. Such regulations shall require the submission, at least annually, of such information as the commissioner or the commissioner of capital asset management and maintenance may deem necessary to monitor the costs and benefits of contracts for energy management services.

(d) The commissioner shall enforce the requirements of this section and regulations adopted hereunder as they relate to local governmental bodies and shall have all the necessary powers to require compliance. The commissioner of capital asset management and maintenance shall enforce all such regulations as they relate to state agencies and building authorities, except quasi-public agencies. An order of the commissioner under this subsection shall be effective and may be enforced according to its terms, and enforcement thereof shall not be suspended or stayed by the entry of an appeal therefrom. The superior court for Suffolk county shall have jurisdiction over appeals of orders of the commissioner under this subsection, and shall also have jurisdiction upon application of the commissioner to enforce all orders of the commissioner under this subsection. The burden of proof shall be upon the appealing party to show that an order of the commissioner is invalid. An aggrieved person shall not be required to seek an order from the commissioner as a condition precedent to seeking any other remedy.

SECTION 24. Section 11D of said chapter 25A, as so appearing, is hereby amended by striking out, in lines 25, 39, 44 and 45, 52, 56, 60 and 62, the word “division” and inserting in place thereof, in each instance, the following word:- department.

B-317

SECTION 25. Said section 11D of said chapter 25A, as so appearing, is hereby further amended by striking out, in lines 30, 39 and 47, the words “telecommunications and energy” and inserting in place thereof the following words:- public utilities.

SECTION 26. Said section 11D of said chapter 25A, as so appearing, is hereby further amended by inserting after the word “department”, in lines 34 and 51, the following words:- of public utilities.

SECTION 27. Said section 11D of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 56, the words “government regulations”, and inserting in place thereof the following words:- telecommunications, utilities and energy.

SECTION 28. Section 11E of said chapter 25A, as so appearing, is hereby amended by striking out, in line 1, the words “division of energy resources” and inserting in place thereof the following word:- department.

SECTION 29. Said section 11E of said chapter 25A, as so appearing, is hereby further amended by striking out, in lines 3 and 4, and in lines 7, 9, 13, 16, 20, 23 and 45, the word “division” and inserting in place thereof, in each instance, the following word:- department.

SECTION 30. Said section 11E of said chapter 25A, as so appearing, is hereby further amended by striking out, in lines 7, 10 and 43, the words “telecommunications and energy” and inserting in place thereof, in each instance, the following words:- public utilities.

SECTION 31. Said section 11E of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 46, the words “committees on government regulations and energy, respectively,” and inserting in place thereof the following words:- committee on telecommunications, utilities and energy.

SECTION 32. Said chapter 25A is hereby further amended by striking out section 11F, as so appearing, and inserting in place thereof the following 2 sections:-

Section 11F. (a) The department shall establish a renewable energy portfolio standard for all retail electricity suppliers selling electricity to end-use customers in the commonwealth. By December 31, 1999 , the department shall determine the actual percentage of kilowatt-hours sales to end-use customers in the commonwealth which is derived from existing renewable energy generating sources. Every retail supplier shall provide a minimum percentage of kilowatt-hours sales to end-use customers in the commonwealth from new renewable energy generating sources, according to the following schedule: (1) an additional 1 per cent of sales by December 31, 2003 , or 1 calendar year from the final day of the first month in which the average cost of any renewable technology is found to be within 10 per cent of the overall average spot-market price per kilowatt-hour for electricity in the commonwealth, whichever is sooner; (2) an additional one-half of 1 per cent of sales each year

B-318

thereafter until December 31, 2009 ; and (3) an additional 1 per cent of sales every year thereafter. For the purpose of this subsection, a new renewable energy generating source is one that begins commercial operation after December 31, 1997 , or that represents an increase in generating capacity after December 31, 1997 , at an existing facility. Commencing on January 1, 2009 , such minimum percentage requirement shall be known as the “Class I” renewable energy generating source requirement.

(b) For the purposes of this subsection, a renewable energy generating source is one which generates electricity using any of the following: (1) solar photovoltaic or solar thermal electric energy; (2) wind energy; (3) ocean thermal, wave or tidal energy; (4) fuel cells utilizing renewable fuels; (5) landfill gas; (6) waste-to-energy which is a component of conventional municipal solid waste plant technology in commercial use; (7) naturally flowing water and hydroelectric; (8) low emission advanced biomass power conversion technologies using fuels such as wood, by-products or waste from agricultural crops, food or animals, energy crops, biogas, liquid biofuel including but not limited to biodiesel, organic refuse-derived fuel, or algae; or (9) geothermal energy; provided, however, that the calculation of a percentage of kilowatt-hours sales to end-use customers in the commonwealth from new renewable generating sources shall exclude clauses (6) and (7). The department may also consider any previously operational biomass facility retrofitted with advanced conversion technologies as a renewable energy generating source. A renewable energy generating source may be located behind the customer meter within the ISO -NE, as defined in section 1 of chapter 164, control area if the output is verified by an independent verification system participating in the New England Power Pool Generation Information System, in this section called NEPOOL GIS , accounting system and approved by the department.

(c) New renewable energy generating sources meeting the requirements of this subsection shall be known as Class I renewable energy generating sources. For the purposes of this subsection, a Class I renewable energy generating source is one that began commercial operation after December 31, 1997, or represents the net increase from incremental new generating capacity after December 31, 1997 at an existing facility, where the facility generates electricity using any of the following: (1) solar photovoltaic or solar thermal electric energy; (2) wind energy; (3) ocean thermal, wave or tidal energy; (4) fuel cells utilizing renewable fuels; (5) landfill gas; (6) energy generated by new hydroelectric facilities, or incremental new energy from increased capacity or efficiency improvements at existing hydroelectric facilities; provided, however, that (i) each such new facility or increased capacity or efficiency at each such existing facility must meet appropriate and site-specific standards that address adequate and healthy river flows, water quality standards, fish passage and protection measures and mitigation and enhancement opportunities in the impacted watershed as determined by the department in consultation with relevant state and federal agencies having oversight and jurisdiction over hydropower facilities; (ii) only energy from new facilities having a capacity up to 25 megawatts or attributable to improvements that incrementally increase capacity or efficiency by up to 25 megawatts at an existing hydroelectric facility shall qualify; and (iii) no such facility shall involve pumped storage of water or construction of any new dam or water diversion structure constructed later

B-319

than January 1, 1998; (7) low emission advanced biomass power conversion technologies using fuels such as wood, by-products or waste from agricultural crops, food or animals, energy crops, biogas, liquid biofuel including but not limited to biodiesel, organic refuse-derived fuel, or algae; (8) marine or hydrokinetic energy as defined in section 3; or (9) geothermal energy. A Class I renewable generating source may be located behind the customer meter within the ISO -NE control area if the output is verified by an independent verification system participating in the NEPOOL GIS accounting system and approved by the department.

(d) Every retail electric supplier providing service under contracts executed or extended on or after January 1, 2009 , shall provide a minimum percentage of kilowatt-hour sales to end-use customers in the commonwealth from Class II renewable energy generating sources. For the purposes of this section, a Class II renewable energy generating source is one that began commercial operation before December 31, 1997 and generates electricity using any of the following: (1) solar photovoltaic or solar thermal electric energy; (2) wind energy; (3) ocean thermal, wave or tidal energy; (4) fuel cells utilizing renewable fuels; (5) landfill gas; (6) energy generated by existing hydroelectric facilities, provided that such existing facility shall meet appropriate and site-specific standards that address adequate and healthy river flows, water quality standards, fish passage and protection measures and mitigation and enhancement opportunities in the impacted watershed as determined by the department in consultation with relevant state and federal agencies having oversight and jurisdiction over hydropower facilities; and provided further, that only energy from existing facilities up to 5 megawatts shall be considered renewable energy and no such facility shall involve pumped storage of water nor construction of any new dam or water diversion structure constructed later than January 1, 1998; (7) waste-to-energy which is a component of conventional municipal solid waste plant technology in commercial use; (8) low emission advanced biomass power conversion technologies using fuels such as wood, by-products or waste from agricultural crops, food or animals, energy crops, biogas, liquid biofuel including but not limited to biodiesel, organic refuse-derived fuel, or algae; (9) marine or hydrokinetic energy as defined in section 3; or (10) geothermal energy. A facility in clause (7) shall not be a Class II renewable generating source unless it operates or contracts for one or more recycling programs approved by the department of environmental protection. At least 50 per cent of any revenue received by the facility through the sale of Massachusetts RPS-eligible renewable energy certificates shall be allocated to such recycling programs. A Class II renewable generating source may be located behind the customer meter within the ISO -NE control area provided that the output is verified by an independent verification system participating in the NEPOOL GIS accounting system and approved by the department.

(e) Every retail supplier shall annually provide to end-use customers in the commonwealth generation attributes from Class II energy facilities in an amount approved by the department; provided, however, that the department shall specify that a certain percentage of these requirements shall be met through energy generated from a specific technology or fuel type in subsection (d). Such minimum percentage requirement for kilowatt-hour sales from Class II energy generating sources may be adjusted by the department as necessary to promote the continued operation of existing energy

generating resources that meet the requirements of said subsection (d), and may be met through kilowatt-hour sales to end-use customers from any energy generating source meeting the requirements of said subsection (d).

(f) After conducting administrative proceedings, the department may add technologies or technology categories to any list; provided, however, that the following technologies shall not be considered renewable energy supplies: coal, oil, natural gas and nuclear power. The department shall establish and maintain regulations allowing for a retail supplier to discharge its obligations under this section by making an alternative compliance payment in an amount established by the department for Class I and Class II renewable energy generating sources. The department shall establish and maintain regulations outlining procedures by which each retail supplier shall annually submit for the department's review a filing illustrating the retail supplier's compliance with the requirements of this section.

(g) In satisfying its annual obligations under subsection (a), each retail supplier shall provide a portion of the required minimum percentage of kilowatt-hours sales from new on-site renewable energy generating sources located in the commonwealth and having a power production capacity of not more than 2 megawatts which began commercial operation after December 31, 2007 , including, but not limited to, behind the meter generation and other similar categories of generation determined by the department. The portion of the required minimum percentage required to be supplied by such on-site renewable energy generating sources shall be established by the department; provided, however, that the department may specify that a certain percentage of these requirements shall be met through energy generated from a specific technology or fuel type.

(h) The department shall adopt regulations allowing for a retail supplier to discharge its obligations under subsection (g) by making an alternative compliance payment in an amount established by the department; provided, however, that the department shall set on-site generation alternative compliance payment rates at levels that shall stimulate the development of new on-site renewable energy generating sources.

(i) A municipal lighting plant shall be exempt from the obligations under this section so long as and insofar as it is exempt from the requirements to allow competitive choice of generation supply under section 47A of chapter 164.

Section 11F1/2. (a) The department shall establish an alternative energy portfolio standard for all retail electricity suppliers selling electricity to end-use customers in the commonwealth. Every retail electric supplier providing service under contracts executed or extended on or after January 1, 2009 shall provide a minimum percentage of kilowatt-hour sales, as determined by the department, to end-use customers in the commonwealth from alternative energy generating sources and the department shall annually thereafter determine the minimum percentage of kilowatt-hour sales to end-use customers in the commonwealth which shall be derived from alternative energy generating sources.

B-321

For the purposes of this section, an alternative energy generating source is one which generates electricity using any of the following: (1) gasification with capture and permanent sequestration of carbon dioxide; provided, however, that the fuel shall be purchased by, and contractually transported to, the alternative energy generating source in ISO -NE, as defined in section 1 of chapter 164; (2) combined heat and power; (3) flywheel energy storage; (4) any facility which substitutes any portion of its fossil fuel source with an equal to or greater portion of an alternative, paper-derived fuel source approved by the department of environmental protection through a beneficial use determination for the production of heat or power; (5) energy efficient steam technology; or (6) any other alternative energy technology approved by the department under an administrative proceeding conducted under chapter 30A; provided, however, that the following technologies shall not be considered alternative energy supplies: coal, except when used in gasification; petroleum coke, except when used in gasification; oil; natural gas, except when used in gasification or combined heat and power; and nuclear power.

(b) The department, in consultation with the department of environmental protection, shall set: (1) emission performance standards, including standards for carbon dioxide emissions, permanent sequestration definitions and standards, and fuel conversion efficiency standards for all technologies included in this section such that in the case of gasification, the total overall fuel conversion efficiency from feedstock to final combustible fuel shall not be less than 70 per cent, consistent with the commonwealth's environmental goals, including, but not limited to, the reduction of greenhouse gas emissions; and (2) a net carbon dioxide emissions rate not to exceed the average emissions rate of existing natural gas plants in the commonwealth, which shall include all emissions related to combustion, gasification, fuel processing and sequestration, whether or not such activities occur at the alternative generating source or at another location, and in the case of combined heat and power shall also include thermal delivery. At least once every 2 years the department shall review and update all standards for new alternative energy generating sources to strengthen them, as appropriate, as technology improvements occur.

(c) The department shall adopt regulations allowing for a retail supplier to discharge its obligations under this section by making an alternative compliance payment in an amount established by the department. Such regulations shall outline procedures by which each retail supplier shall annually submit for the department's review a filing illustrating the retail supplier's compliance with the requirements of this section.

(d) A municipal lighting plant shall be exempt from the obligations under this section so long as and insofar as it is exempt from the requirements to allow competitive choice of generation supply under section 47A of chapter 164.

SECTION 33. Section 11G of said chapter 25A, as so appearing, is hereby amended by striking out, in lines 1, 3 and 11, the word "division" and inserting in place thereof, in each instance, the following word:- department.

B-322

SECTION 34. Said section 11G of said chapter 25A, as so appearing, is hereby further amended by inserting after the word “department”, in lines 13 and 14, the following words:- of public utilities.

SECTION 35. Said section 11G of said chapter 25A, as so appearing, is hereby further amended by striking out the last 2 sentences and inserting in place thereof the following sentence:- The department shall adopt rules and regulations necessary to implement this section.

SECTION 36. Section 11H of said chapter 25A, as so appearing, is hereby amended by striking out, in lines 1, 6, 12 and 31, the word “division” and inserting in place thereof, in each instance, the following word:- department.

SECTION 37. Said chapter 25A is hereby amended by striking out section 11I and inserting in place thereof the following section:-

Section 11I. (a) A state agency, local governmental body or building authority may use this section in the procurement of energy management services as an alternative to the procedures in section 11C. Nothing in this section shall preclude any such agency, body or authority from proceeding under section 11C.

(b) An agency, local governmental body or building authority may enter into an energy management services contract in order to achieve energy savings at facilities in accordance with this section. All energy savings measures under the contract shall comply with current local, state and federal construction and environmental codes and regulations.

(c) Before entering into an energy management services contract, a state agency, local governmental body or building authority shall issue a request for qualifications. Public notice of the request for qualifications shall conform to the procedures set forth in subsection (1) of section 44J of chapter 149. At least 1 week before soliciting a request for qualifications for an energy management services contract, an agency, body or authority body shall notify the commissioner in writing, in a form and including information as the commissioner of capital asset management and maintenance shall prescribe by regulation, of the entity’s intent to solicit qualifications. The notification, at a minimum, shall include a copy of the request for qualifications. An acknowledgment of receipt, in a form and including information as the commissioner of capital asset management and maintenance shall prescribe by regulation, shall be issued by the commissioner to the agency, body or authority upon compliance with the requirements of this subsection.

The request for qualifications published by a state agency, local governmental body or building authority shall include the following: (1) the name and address of the agency, body or authority; (2) The name, address, title and phone number of a contact person; (3) the date, time and place where qualifications shall be received; (4) a description of the services to be procured, including a facility profile with a detailed description of each building involved and accurate energy consumption data for the most recent 2-year period, stated objectives for the program, a list of building improvements to be considered or

B-323

required and a statement as to whether the proposed improvements will generate sufficient energy savings to fund the full cost of the program; (5) the evaluation criteria for assessing the qualifications; (6) a statement that the agency, body or authority may cancel the request for qualifications, or may reject in whole or in part any and all energy savings measures, when it determines that cancellation or rejection serves the best interests of the public; and (7) any other stipulations and clarifications the agency, body or authority may require, which shall be clearly identified in the request for qualifications.

Qualifications shall be opened publicly, in the presence of 2 or more witnesses, at the time specified in the request for qualifications, and shall be available for public inspection. The provisions of sections 44A, 44B and 44E to 44H, inclusive, of chapter 149 shall not apply to contracts procured under this section. Section 44D of said chapter 149 shall apply as appropriate to qualifications submitted for contracts under this section, and every such qualification shall be accompanied by (1) a copy of a certificate of eligibility issued by the commissioner of capital asset management and maintenance, and (2) by an update statement.

The state agency, local governmental body or building authority shall evaluate the qualified providers to determine which best meets the needs of the public agency by reviewing the following:

(1) references of other energy savings contracts performed by the qualified providers;

(2) the certificate of eligibility and update statement provided by the qualified providers;

(3) quality of the products proposed;

(4) methodology of determining energy savings;

(5) general reputation and performance capabilities of the qualified providers;

(6) substantial conformity with the specifications and other conditions set forth in the request for qualifications;

(7) time specified in the qualifications for the performance of the contract; and

(8) any other factors the agency, body, or authority considers reasonable and appropriate, which factors shall be made a matter of record.

Respondents shall be evaluated only on the criteria set forth in the request for qualifications.

The state agency, local governmental body or building authority shall conduct discussions with, and may require public presentations by, each person who submitted qualifications in response to the request for qualifications regarding his qualifications, approach to the project and ability to furnish the required services. The agency, body or authority shall select in order of preference 3 such persons, unless fewer persons respond, it considers to be the most highly qualified to perform the required services. The agency, body or authority may request, accept and consider proposals for the compensation to be paid under the contract only during competitive negotiations conducted under subsection (e).

(d) The state agency, local governmental body or building authority may cancel a request for qualifications, or may reject in whole or in part any and all proposals when it

determines that cancellation or rejection serves its best interests. The agency, body or authority shall state in writing the reason for a cancellation or rejection.

(e) The state agency, local governmental body or building authority shall negotiate a contract with the most qualified person at compensation which it determines is fair, competitive and reasonable. If the agency, body or authority is unable to negotiate a satisfactory contract with the person considered to be the most qualified at a price the agency, body or authority determines to be fair, competitive and reasonable, negotiations with that person shall be formally terminated. The agency, body or authority shall then undertake negotiations with the second most qualified person. Failing accord with the second most qualified person, the agency, body or authority shall terminate those negotiations and then undertake negotiations with the third most qualified person. Should the agency, body or authority be unable to negotiate a satisfactory contract with any of the selected persons, it may select additional qualified providers who responded to the request for qualifications, in the order of their competence and qualification, and continue negotiations in accordance with this subsection until either an agreement is reached or the agency, body or authority cancels the request for qualifications.

(f) The decision of the state agency, local governmental body or building authority regarding the selection of a qualified provider shall be final and not subject to appeal except on the grounds of fraud or collusion.

(g) The state agency, local governmental body or building authority shall provide public notice of the meeting at which it proposes to award the energy management services contract, of the name of the parties to the proposed contract and of the purpose of the contract. The public notice shall be made at least 10 days before the meeting. The agency, body or authority shall promptly publish in the central register notice of the award and shall notify the commissioner of the award and provide to him a copy of the energy management services contract.

(h) The energy management services contract shall include a written guarantee of the qualified provider that either the amount of energy savings guaranteed shall be achieved or the qualified provider shall reimburse the state agency, local governmental body or building authority for the shortfall amount. Methods for measurement and verification of energy savings shall conform to the most recent standards established by the Federal Energy Management Program of the United States Department of Energy.

(i) The commissioner, in consultation with the commissioner of capital asset management and maintenance, shall adopt regulations for the procurement of energy management services under this section for local government bodies. The commissioner shall enforce the requirements of this section and regulations adopted as they relate to local governmental bodies and shall have all the necessary powers to require compliance. The commissioner of capital asset management and maintenance shall adopt regulations for services to be procured for state agencies and building authorities. The commissioner of capital asset management and maintenance shall enforce the regulations as they relate to state agencies and building authorities. An order of the commissioner under this subsection shall be effective and may

B-325

be enforced according to its terms, and enforcement shall not be suspended or stayed by the entry of an appeal. The superior court for Suffolk county shall have jurisdiction over appeals of orders of the commissioner under this subsection, and shall also have jurisdiction upon application of the commissioner to enforce all orders of the commissioner under this subsection. The burden of proof shall be upon the appealing party to show that an order of the commissioner is invalid. An aggrieved person shall not be required to seek and order from the commission as a condition precedent to seeking any other remedy.

(j) Payments under a contract for energy management services may be based in whole or in part on any cost savings attributable to a reduction in energy and water consumption due to the contractor's performance or revenues gained due to the contractor's services which are aimed at energy and water cost savings.

(k) Unless no other manner of description suffices, and the state agency, local governmental body or building authority so determines in writing, setting forth the basis for the determination, all requirements shall be written in a manner which describes the requirements to be met without having the effect of exclusively requiring a proprietary supply or service, or a procurement from a sole source.

(l) Before entering into a energy management services contract, the state agency, local governmental body or building authority shall require the qualified provider to file with the agency, body or authority a payment or a performance bond relating to the installation of energy savings measures in an amount equal to 100 per cent of the estimated contract value from a surety company licensed to do business in the commonwealth and whose name appears on United States Treasury Department Circular 570.

(m) An energy management services contract may extend beyond the fiscal year in which it became effective.

SECTION 38. Section 12 of said chapter 25A, as so appearing, is hereby amended by striking out, in line 15, the word "energy" and inserting in place thereof the following words:- telecommunications, utilities and energy.

SECTION 39. Said section 12 of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 21, the words "said chairmen" and inserting in place thereof the following word:- committee.

SECTION 40. Section 13 of said chapter 25A, as so appearing, is hereby amended by striking out, in line 2 and in lines 16 and 17, the word "division" and inserting in place thereof, in each instance, the following word:- department.

SECTION 41. Said section 13 of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 16, the words "division of energy resources" and inserting in place thereof the following word:- department.

B-326

SECTION 42. Said section 13 of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 10, the word “Division”, and inserting in place thereof the following word:- Department.

SECTION 43. Said section 13 of said chapter 25A, as so appearing, is hereby further amended by striking out, in line 15, the words “subject to” and inserting in place thereof the following words:- without further.

SECTION 44. Said chapter 25A is hereby further amended by adding the following 2 sections:-

Section 14. (a) A state agency, building authority or local governmental body may contract for energy conservation projects that have a total project cost of $100,000 or less, directly and without further solicitation, with electric and gas utilities, their subcontractors and other providers of such energy conservation projects authorized under sections 19 and 21 of chapter 25 and section 11G.

(b) For purposes of this section, "total project cost" shall mean all construction costs of an energy conservation project, whether borne by the utility, agency, authority or body including, without limitation, the costs associated with equipment purchase and installation of such equipment. Ancillary services provided at no cost by utilities, such as auditing and design, shall not be considered part of project cost.

(c) A state agency, building authority or local governmental body may pay for such energy conservation projects through additions to their monthly utility bills.

(d) Sections 44A to 44M, inclusive, of chapter 149 and section 39M of chapter 30 shall not apply to contracts entered into under this section.

Section 15. (a) For solar photovoltaic projects with a total project cost that is less than $100,000, a state agency, building authority or local governmental body may acquire photovoltaic panels and associated equipment for onsite use of the energy generated by these panels from contracts procured by the operational services division under section 22 of chapter 7 and sections 51 and 52 of chapter 30.

(b) For purposes of this section, "total project cost" shall mean all construction costs of a photovoltaic project, whether borne by the utility, agency, authority or body or other sources, including, without limitation, the costs associated with equipment purchase and installation of such equipment. Ancillary services provided at no cost, such as auditing and design, shall not be considered part of project cost.

(c) Sections 44A to 44M, inclusive, of chapter 149 and section 39M of chapter 30 shall not apply to contracts entered into under this section.

B-327

SECTION 45. Section 2 of chapter 25B of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by striking out, in line 11, the words “of the division”

SECTION 46. Section 1 of chapter 30B of the General Laws, as so appearing, is hereby amended by striking out, in line 96, the words “telecommunications and energy” and inserting in place thereof the following words:- public utilities.

SECTION 47. Said section 1 of said chapter 30B of the General Laws, as so appearing, is hereby further amended by striking out, in line 97, the word “division” and inserting in place thereof the following word:- department.

SECTION 48. Section 3 of chapter 40J of the General Laws, as so appearing, is hereby amended by inserting after the word “designee”, in line 14, the following words:- , the secretary of energy and environmental affairs or a designee,.

SECTION 49. Said chapter 40J is hereby amended by striking out section 4E, as so appearing, and inserting in place thereof the following section:-

Section 4E. (a)(1) There is hereby established and set up on the books of the corporation a separate trust fund to be known as the Massachusetts Renewable Energy Trust Fund, hereinafter referred to as the fund. The corporation shall hold the fund in an account or accounts separate from other funds. There shall be credited to the fund all amounts collected under section 20 of chapter 25 and any income derived from the investment of amounts credited to the fund. All amounts credited to the fund shall be held in trust and used solely for activities and expenditures consistent with the public purpose of the fund as set forth in subsection (b) of this section, including the ordinary and necessary expenses of administration and operation associated with the fund. Unless otherwise specified, all monies of the corporation, from whatever source derived, shall be paid to the treasurer of the corporation. Said monies shall be deposited in the first instance by the treasurer in national banks, trust companies or banking companies in compliance with section 34 of chapter 29. Funds in such accounts shall be paid out on the warrant or other order of the treasurer of the corporation or other person as the board may authorize to execute warrants.

(a)(2) A governing board of not less than 9 individuals with an interest in matters relating to the general purpose of the fund shall assist the corporation in matters related to the fund and in the implementation of this section. The governing board shall include: the commissioner of energy resources, who shall serve as chair; the secretary of energy and environmental affairs or a designee, the secretary of housing and economic development or a designee; the secretary of administration and finance or a designee; 1 member of the board to be appointed by the chair of the board; and 4 members to be appointed by the governor, who shall have knowledge and experience in the following areas: electricity distribution, generation, supply or power marketing; the concerns of commercial and industrial ratepayers; the concerns of residential ratepayers, including low-income ratepayers;

economics, financial or investment consulting relative to the fund; regional environmental concerns; academic issues related to power generation, distribution or the development or commercialization of renewable energy sources; institutions of higher education; municipal or regional aggregation matters; and renewable and alternative energy and energy efficiency issues. The members of the governing board shall be deemed to be directors for the purposes of the fourth paragraph of section 3. Each appointed member of the governing board shall serve for a term of 3 years and thereafter until such member's successor is appointed, and shall be eligible for reappointment. A person appointed to fill a vacancy on the governing board shall be appointed in a like manner as the vacating member shall have been appointed and shall be eligible for reappointment. A member of the governing board appointed by the governor may be removed by the governor for cause. The members of the governing board shall serve without compensation, but each member shall be entitled to reimbursement for actual and necessary expenses incurred in the performance of official duties. The governing board may meet as often as the members shall decide; provided, however, that it shall meet at least quarterly. The governing board may, by majority vote, delegate any amount of its authority to an executive committee comprised of members of the governing board, the board or the staff of the corporation. Any such delegation of authority may be revoked at any time by majority vote of the governing board.

The governing board shall adopt and submit to the board for approval detailed 5-year strategic plans and annual operational plans for the application of the fund in support of the design, implementation, evaluation and assessment of renewable energy programs for the commonwealth that ensure that the fund shall be employed to provide financial and non-financial resources to overcome barriers facing renewable energy enterprises, institutions and projects in a prudent manner consistent with the public purposes and interests set forth in this section. The strategic plan shall include consideration of, and be consistent with, plans, regulations and policies issued by the executive office of energy and environmental affairs and, to the extent practicable, shall consist of at least 4 components: (i) product and market development to establish a foundation for growth and expansion of the commonwealth's renewable energy enterprises, institutions and projects, including pilot and demonstration projects, production incentives, and other activities designed to increase the use and affordability of renewable energy in the commonwealth; (ii) training and public information to allow for the development and dissemination of complete, objective and timely information, analysis and policy recommendations related to the advancement of the public purposes and interests of the renewable energy fund; (iii) investment to support the growth and expansion of renewable energy enterprises, institutions and projects; and (iv) research and development within the commonwealth and the New England region related to renewable energy matters. The strategic plans and annual operational plans shall also allocate a portion of the fund to the green communities program to provide technical assistance to municipalities certified as green communities under section 10 of chapter 25A. The strategic plans and annual operational plans shall provide detailed budget and staffing levels and specify the expenditure of such monies from the fund to each of these component activities; provided, however, that monies so expended shall be used to develop such renewable energy projects with priority given to projects, institutions, and enterprises, first, within the commonwealth; next, to such

activities within New York and the New England region which serve the regional power grid; and finally, all other such activities regardless of location. In developing the strategic plans and yearly operational plans, the governing board shall consult with and utilize the services of the department of public utilities and the department of energy resources for such technical assistance as the governing board deems necessary or appropriate to the effective discharge of the governing board's responsibilities and duties relative to the fund.

The 5-year strategic plans and annual operational plans shall be deemed approved unless they are rejected by a majority vote of the board within 60 days of the plan's referral to the board. If the board rejects any submitted plan, the board shall, within 10 days of such action, provide the governing board with a written explanation of the denial, including any proposed recommendations to the submitted plan. Upon approval by the board of any plan, the board shall delegate authority to the governing board to implement the plan. The delegated authority shall include, but not be limited to, the approval and implementation of budget and staffing projections set forth in the plan, the hiring of an executive director to administer the fund at the direction of the governing board, and the hiring of outside consultants or other professionals to assist in the implementation of the plan. The governing board shall present any subsequent strategic plans and annual operational plans, or substantial modifications of any approved plan, to the board for approval. The board shall not be liable for any claims arising out of or related to the implementation of any approved plan, or any other decisions of the governing board relating to administration of the fund.

(b) The board shall draw upon monies in the fund for the public purpose of generating the maximum economic and environmental benefits over time from renewable energy to the ratepayers of the commonwealth through a series of initiatives which exploit the advantages of renewable energy in a more competitive energy marketplace by promoting the increased availability, use and affordability of renewable energy, by making operational improvements to existing renewable energy projects and facilities which, in the determination of the governing board, would yield more significant results in the development of renewable energy if said funds were made available for the creation of new renewable energy facilities, and by fostering the formation, growth, expansion and retention within the commonwealth of preeminent clusters of renewable energy and related enterprises, institutions and projects, which serve the citizens of the commonwealth consistent with a strategic plan or annual operational plan.

(c) Public interests to be advanced through the governing board's actions shall include, but not be limited to, the following: (i) the development and increased use and affordability of renewable energy resources in the commonwealth and the New England region; (ii) the protection of the environment and the health of the citizens of the commonwealth through the prevention, mitigation and alleviation of the adverse pollution effects associated with certain electricity generation facilities; (iii) the maximization of benefits to consumers of the commonwealth resulting from increased fuel and supply diversity; (iv) the creation of additional employment opportunities in the commonwealth through the development of renewable technologies; (v) the stimulation of increased public and private sector

B-330

investment in, and competitive advantage for, renewable energy and related enterprises, institutions and projects in the commonwealth and the New England region; and (vi) the stimulation of entrepreneurial activities in these and related enterprises, institutions and projects.

(d) In furtherance of any strategic and operational plans, and other public purposes and interests, the board may expend monies from the fund to make grants, contracts, loans, equity investments, energy production credits, bill credits, or rebates to customers; to provide financial or debt service obligation assistance; or to take any other actions, in such forms, under such terms and conditions and under such selection procedures as the board deems appropriate and otherwise in a manner consistent with good business practices; provided, however, that the board shall generally employ a preference for competitive procurements; provided further, that the board shall endeavor to leverage the full range of the resources, expertise and participation of other state and federal agencies and instrumentalities in the design and implementation of programs under this section; and provided further, that the board has determined and incorporated into the minutes of its proceedings a finding that such actions are calculated to advance the public purpose and public interests set forth in this section, including, but not limited to, the following: (i) the growth of the renewable energy-provider industry; (ii) the use of renewable energy by electricity customers in the commonwealth; (iii) public education and training regarding renewable energy; (iv) product and market development; (v) pilot and demonstration projects and other activities designed to increase the use and affordability of renewable energy resources by and for consumers in the commonwealth; (vi) the provision of financing in support of the development and application of related technologies at all levels, including, but not limited to, basic and applied research and commercialization activities; (vii) the design and making of improvements to existing renewable energy projects and facilities as defined herein which were in operation as of December 31, 1997 ; and (viii) matters related to the conservation of scarce energy resources.

(e) Subject to the approval of the board, and not inconsistent with any strategic or annual operational plans, investment activity of monies from the fund may consist of the following: (i) an equity fund, to provide risk capital to renewable energy enterprises, institutions and projects; (ii) a debt fund, to provide loans to energy enterprises, institutions, projects, intermediaries and end-users; and (iii) a market growth assistance fund, to be used to attract private capital to the equity and debt funds. To implement these investment activities, the corporation may retain, through a bid process, public or private sector investment fund managers, who shall have prior knowledge and experience in fund management and possess related skills in renewable energy and related technologies development, to direct the investment activity described in this section and to seek other fund co-sponsors to contribute public and private capital from the commonwealth and other states; provided, however, that such capital shall be appropriately segregated. The managers, subject to the approval of the board, may retain necessary services and consultants to carry out the purposes of the fund. The managers shall develop a business plan to guide investment decisions, which shall be approved by the board before any expenditures from the trust fund and which shall be consistent with the provisions of the plan for the fund as adopted by the board.

B-331

(f) For the purposes of expenditures from the fund, renewable energy technologies eligible for assistance shall mean technologies eligible as Class I or Class II renewable energy generating sources under section 11F of chapter 25A, micro-combined heat and power units less than 60 kilowatts, solar hot water, geothermal heating and cooling projects, biomass thermal and storage and conversion technologies connected to qualifying generation projects; provided, however, that the board may make grants from the fund, not to exceed a total of $4 million annually, in support of Massachusetts-based public and private enterprises developing new technologies to significantly increase the efficiency of the internal combustion engine. The board shall make grants, loans or other support from the fund, not to exceed $3 million annually for hydroelectric facilities, other than pumped storage facilities in the commonwealth, constructed before December 31, 1997 for upgrades to increase efficiency or capacity and to reduce environmental impacts. Such funds may also be used for appropriate joint energy efficiency and renewable projects, as well as for investment by distribution companies in renewable energy and distributed generation opportunities, if consistent with this section. The following technologies or fuels shall not be considered renewable energy supplies: coal, oil, natural gas except when used in fuel cells or micro-combined heat and power, and nuclear power.

(g) The use by the corporation and governing board of monies to implement this section shall be deemed to be an essential governmental function. Notwithstanding any general or special law to the contrary, clause (a) of section 4A shall apply to expenditures made from the fund; provided, however, that no such expenditure shall be deemed to involve a capital facility project; provided further, that no lease or license executed in furtherance of the public purpose and interests of the fund shall exceed 30 years in duration, and the duration and terms shall be developed in a manner consistent with good business practices; and provided further, that the corporation or governing board shall take no action which contravenes the commonwealth's reversionary interest in any of its real property. The corporation, any purchasing cooperative established thereby and all members of any such purchasing cooperative may participate in any energy-related purchasing, aggregating or similar program established and operated by the Health and Educational Facilities Authority and such participation shall be deemed to be in furtherance of an essential governmental function.

(h) Clause (k) of section 4 shall not apply to disbursements from the trust fund.

(j) The books and records of the corporation and governing board relative to expenditures and investments of monies from the fund shall be subject to a biennial audit by the auditor of the commonwealth.

(k) Not later than August 15th of each year, the board, in conjunction with the governing board, shall annually submit to the governor, the joint committee on telecommunications, utilities and energy, and the senate and house committees on ways and means a report detailing the expenditure and investment of monies from the fund over the previous fiscal year, the ability of the fund to meet the requirements in this section, and any recommendations for improving the ability of the governing board, the board, the corporation and the fund to meet such requirements.

B-332

(l) Notwithstanding any general or special law to the contrary, including without limitation any laws related to the procurement of electricity, the board shall, upon the written request of the governor, transfer moneys in the fund, in an amount not exceeding $17 million in the aggregate, to the commonwealth for deposit in the General Fund. As a condition subsequent to any such transfer, the commonwealth, acting by and through the department of energy resources or a successor agency, shall enter into an agreement with the corporation under which the commonwealth, at the direction of the corporation, shall enter into contracts, for terms not to exceed 20 years, with owners of facilities that generate electricity using renewable energy technologies, wholesale power marketers or other market intermediaries selling such electricity, for the purchase by the commonwealth, for its own use or for the use of any municipal electric department, public instrumentality or other governmental or nongovernmental entity in the commonwealth, of electricity produced by renewable energy technologies. The corporation shall determine the particular types of technologies which shall be the subject of any such contract based on such criteria as it shall deem advisable, including without limitation retail consumer choices of such renewable energy technologies. The aggregate dollar amount of the green power premium associated with electricity purchases to be made by the commonwealth for its own use under such contracts shall have a present value, determined according to such discount rate as shall be mutually agreeable to the corporation and the commonwealth, of such amount as shall be transferred under the first sentence of this paragraph. The green power premium shall be determined by subtracting from the total amount of the purchase price the undifferentiated commodity price for electricity under then-current commonwealth contracts. The maximum payment in any 1 fiscal year under all such contracts shall not exceed $5 million. The commonwealth shall be indemnified under such contracts by the owners or power marketers on such terms as the corporation shall deem commercially reasonable. The amounts collected under section 20 of chapter 25 shall be impressed with a trust for the benefit of the fund. To facilitate the purchase by the corporation of electricity produced by renewable energy technologies or of certificates produced under the renewable energy portfolio standard regulations of the department of energy resources representing the generation attributes of electrical energy produced by renewable energy technologies, and in consideration of the sale of such electricity or certificates, the commonwealth shall covenant with the sellers of such electricity or certificates that the amounts collected under said section 20 shall not be diverted from the fund and that the rates of the mandatory charges under said section 20 shall not be reduced during the term, which shall not exceed 20 years, of any contract entered into by the corporation for the purchase of such electricity or certificates below a level which shall enable the corporation to fulfill the terms of such contracts. In furtherance of the public purposes of the fund, income derived from the investment of amounts collected under said section 20 shall be expended by the corporation as provided in subsection (a) and, in the discretion of the corporation, in furtherance of the public purposes of the corporation and for such costs of departments and agencies that support or are otherwise consistent with the purposes of the fund.

SECTION 50. Section 7 of chapter 44 of the General Laws, as so appearing, is hereby amended by striking out clause (3B) and inserting in place thereof the following clause:-

B-333

(3B) For energy conservation, alternative energy or renewable energy improvements to public buildings or facilities owned or leased by the city or town, or on property owned or leased by the city or town, 20 years.

SECTION 51. Section 1 of chapter 90 of the General Laws, as amended by section 1 of chapter 79 of the acts of 2008, is hereby further amended by inserting before the definition of “Ambulance” the following 2 definitions:-

“Alternative fuel”, an energy source used to power a vehicle that does not meet the definition of fuel in section 1 of chapter 64A and is not diesel motor fuel.

“Alternative fuel vehicle”, a vehicle powered by alternative fuel with the following attributes:

(a) the capability of operating only on alternative fuel;

(b) its original use was commenced with the taxpayer;

(c) acquired by the taxpayer for use or lease, but not for resale;

(d) is designed to use and uses alternative fuel for a significant portion of the total fuel used for propulsion energy for the vehicle; and

(e) when operating on petroleum fuel, the vehicle model's miles per gallon rating from the United States Environmental Protection Agency exceeds the agency's corporate average fuel economy requirement for the class of vehicles, whether cars or light trucks, in which the vehicle model is classified. The model specification shall include characteristics that affect fuel economy and for which the United States Environmental Protection Agency issues distinct miles per gallon ratings, such as transmission type and engine size.

SECTION 52. Said section 1 of said chapter 90, as so appearing, is hereby further amended by inserting after the definition of “House trailer” the following definition:-

“Hybrid vehicle”, a vehicle (a) which draws propulsion energy from onboard sources of stored energy which are both: (1) an internal combustion or heat engine using combustible fuel; and (2) a rechargeable energy storage system; or (b) which, in the case of a passenger vehicle, medium duty passenger vehicle or light truck: (1) for model year 2002 and later model year vehicles, has received a certificate of conformity under the Clean Air Act and meets or exceeds the equivalent qualifying California low emission vehicle standard adopted under section 243(e)(2) of said Clean Air Act for that make and model year; (2) for model year 2004 and later model vehicles, has received a certificate that the vehicle meets or exceeds the Tier II Bin 5 emission level established in regulations prescribed by the Administrator of the United States Environmental Protection Agency under section 202(i) of said Clean Air Act for that make and model year vehicle; and (3) achieves an increase of 10 per cent fuel

B-334

efficiency as compared to the average vehicle of its class as defined by the United States Environmental Protection Agency.

SECTION 53. Subclause (3) of clause (b) of the definition of “hybrid vehicle” in said section 1 of said chapter 90, as appearing in section 52, is hereby amended by striking out the figure “10” and inserting in place thereof the following figure:- 25.

SECTION 54. Section 3 of chapter 143 of the General Laws, as so appearing, is hereby amended by inserting after the word “structure”, in line 55, the following words:- , and the energy requirements imposed by clause (p) of section 94.

SECTION 55. Said section 94 of said chapter 143, as amended by section 1 of chapter 78 of the acts of 2008, is hereby further amended by adding the following 4 clauses:-

(o) To adopt and fully integrate the latest International Energy Conservation Code as part of the state building code, together with any more stringent energy-efficiency provisions that the board, in consultation with the department of energy resources, concludes are warranted. The energy provisions of the state building code shall be updated within 1 year of any revision to the International Energy Conservation Code.

(p) In consultation with the department of energy resources, to develop requirements and promulgate regulations as part of the state building code for the training and certification of city and town inspectors of buildings, building commissioners and local inspectors regarding the energy provisions of the state building code, and to require that all new construction and any major reconstruction, alteration or repair of residential and non-residential buildings pass inspection by inspectors who have been trained and certified, demonstrating full compliance with the energy provisions of the state building code.

(q) In consultation with the department of energy resources, to develop requirements and promulgate regulations as part of the state building code, in addition to the requirements of the latest International Energy Conservation Code, requiring a process to ensure that all new non-residential buildings larger than 10,000 square feet and any major reconstruction, alteration or repair of all such buildings perform as designed with respect to energy consumption by undergoing building commissioning or acceptance testing. Such commissioning must be completed before the issuance of a certificate of occupancy.

(r) In consultation with the department of energy resources, professional organizations and other stakeholders, to prepare a report evaluating the advisability of a requirement of periodic commissioning for large non-residential buildings and, if such a requirement is deemed advisable, evaluating possible approaches to periodic commissioning.

B-335

SECTION 56. Chapter 159 of the General Laws is hereby amended by striking out section 10, as amended by section 30 of chapter 19 of the acts of 2007, and inserting in place thereof the following section:-

Section 10. The department of telecommunications and cable shall enforce this chapter to the extent that it relates to telecommunications. The department of public utilities shall enforce all other provisions.

SECTION 57. Chapter 164 of the General Laws is hereby amended by striking out section 1, as amended by section 36 of said chapter 19, and inserting in place thereof the following section:-

Section 1. In this chapter, unless the context otherwise requires, the following words shall have the following meanings:

“Aggregator”, an entity which groups together electricity customers for retail sale purposes, except for public entities, quasi-public entities or authorities, or subsidiary organizations thereof, established under the laws of the commonwealth.

“Alternative energy development”, shall include, but shall not be limited to, solar energy, wind, wood, alcohol, hydroelectric, biomass energy systems, renewable non-depletable and recyclable energy sources.

“Alternative energy producer”, a person, firm, partnership, association, public or private corporation, or an agency, department, board, commission or authority of the commonwealth or of a subdivision of the commonwealth, that owns or operates a cogeneration facility or small power production facility as defined in this section, and does not engage in the retail sale of electricity other than sales to customers that are within the confines of an industrial park, which existed before March 1, 1982 , and in which there existed as of said date electrical generating capacity of more than 15 megawatts.

“Alternative energy property”, any property powered in whole or in part by the sun, wind, water, biomass, alcohol, wood, or any renewable, non-depletable or recyclable fuel, and property related to the exploration, development, processing, transportation and distribution of the aforementioned energy resources.

“Ancillary services”, those functions which support generation, transmission, and distribution, and which shall include the following services: (1) reactive power or voltage control; (2) loss compensation; (3) scheduling and dispatch; (4) load following; (5) system protection service; and (6) energy imbalance service.

“Articles of organization”, (i) the articles of organization of a corporation which were filed after

B-336

October 1, 1973 ; (ii) an agreement of association, special act of incorporation and other charter documents, including by-law provisions and stockholder votes in effect before October 1, 1973 , which, after that date, would be included in articles of organization, and all amendments thereto, effective before October 1, 1973 ; and (iii) any of the following amendments made or filed from time to time subsequent to October 1, 1973 :

(1) a certificate of a vote establishing a series filed under section 26 of chapter 156B;

(2) articles of amendment filed under section 8B;

(3) restated articles of organization filed under section 8C;

(4) certificates of confirmation of proceedings filed under section 8D;

(5) articles of consolidation or merger filed under section 102A;

(6) articles of dissolution filed under section 100 of chapter 156B;

(7) a certificate as to the revival of a corporation filed under section 108 of chapter 156B.

“Basic service”, the electricity services provided to a retail customer upon either: (i) the inability of a customer to receive competitive supply from a supplier under subsection (d) of section 1B; (ii) the failure of the retail customer to elect competitive supply from a supplier under said subsection (d) of said section 1B; or (iii) upon the expiration of and the retail customer’s failure to renew a competitive supply contract under said subsection (d) of said section 1B or other means.

“Cogeneration facility”, any electrical generating unit having a power production capacity which, together with any other facilities located at the same site, is not greater than 30 megawatts and which produces electric energy and steam or other form of useful energy utilized for industrial, commercial, heating or cooling purposes, and employs a fuel other than oil as its primary energy source, except that oil may be used: (1) in combination with coal, in a mixture not exceeding 70 per cent oil; or (2) during any modifications to any existing electrical generating facility undertaken for the purpose of enabling such facility to employ, except during any periods of maintenance or repair, a fuel other than oil as its primary energy source; provided, however, that cogeneration facility shall also include any electric generating unit having a power production capacity which, together with any other facilities located at the same site, is not greater than 30 megawatts and which produces electric energy and steam or other form of useful energy utilized for industrial, commercial, heating or cooling purposes that is within the confines of an industrial park, which existed before March 1, 1982 and, in which park there existed, as of said date, electrical generating capacity of more than 15 megawatts, and in which there existed, since said date, a cogeneration facility or a small power production facility.

“Contract termination fee”, the fees owed by the distribution company to its wholesale power

B-337

supplier, as determined and approved by the department of public utilities.

“Corporation”, a corporation to which this chapter applies, as set forth in section 3.

“Default Service”, the electricity services provided to a retail customer upon: (i) the failure of a distribution company or supplier to provide such electricity services as required by law or as contracted for under the standard service offer; (ii) the completion of the term of the standard service offer; or (iii) the inability of a customer to receive standard service transition rates during the term of the standard service offer under section 1B.

“Department”, the department of public utilities.

“Distributed generation”, a generation facility or renewable energy facility connected directly to distribution facilities or to retail customer facilities which alleviate or avoid transmission or distribution constraints or the installation of new transmission facilities or distribution facilities.

“Distribution”, the delivery of electricity over lines which operate at a voltage level typically equal to or greater than 110 volts and less than 69,000 volts to an end-use customer within the commonwealth. The distribution of electricity shall be subject to the jurisdiction of the department of public utilities.

“Distribution company”, a company engaging in the distribution of electricity or owning, operating or controlling distribution facilities; provided, however, that a distribution company shall not include any entity which owns or operates plant or equipment used to produce electricity, steam and chilled water, or an affiliate engaged solely in the provision of such electricity, steam and chilled water, where the electricity produced by such entity or its affiliate is primarily for the benefit of hospitals and non-profit educational institutions, and where such plant or equipment was in operation before January 1, 1986 .

“Distribution facility”, a plant or equipment used for the distribution of electricity and which is not a transmission facility, a cogeneration facility or a small power production facility.

“Distribution service”, the delivery of electricity to the customer by the electric distribution company from points on the transmission system or from a generating plant at distribution voltage.

“Electric company”, a corporation organized under the laws of the commonwealth for the purpose of making by means of water power, steam power or otherwise and for selling, transmitting, distributing, transmitting and selling, or distributing and selling, electricity within the commonwealth, or authorized by special act so to do, even though subsequently authorized to make or sell gas; provided, however, that electric company shall not mean an alternative energy producer; provided further, that a distribution company shall not include an entity which owns or operates a plant or equipment used to produce electricity, steam and chilled water, or an affiliate engaged solely in the

provision of such electricity, steam and chilled water, where the electricity produced by such entity or its affiliate is primarily for the benefit of hospitals and nonprofit educational institutions, and where such plant or equipment was in operation before January 1, 1986 ; and provided further, that electric company shall not mean a corporation only transmitting and selling, or only transmitting, electricity unless such corporation is affiliated with an electric company organized under the laws of the commonwealth for the purpose of distributing and selling, or distributing only, electricity within the commonwealth.

"Electric service", the provision of generation, transmission, distribution or ancillary services.

"End user", any individual, corporation, firm or subsidiary of a firm that is an ultimate consumer of petroleum products and which, as part of its normal business practices, purchases or obtains petroleum products from a wholesaler or reseller and receives delivery of that product.

"Energy audit", a determination of the energy consumption characteristics of a building or facility which identifies the type, size and rate of energy consumption of such building or facility and the major energy using systems of such building or facility; determines appropriate energy conservation maintenance and operating procedures; and indicates the need, if any, for the acquisition and installation of energy conservation measures or alternative energy property.

"Energy conservation", shall include, but shall not be limited to, the modification of or change in the operation of real or personal property in a manner likely to improve the efficiency of energy use, energy conservation measures and any process to audit or identify and specify energy and cost savings.

"Energy conservation measures", measures involving modifications of maintenance and operating procedures of a building or facility and installations therein, which are designed to reduce energy consumption in such building or facility, or the installation or modification of an installation in a building or facility which is primarily intended to reduce energy consumption.

"Energy conservation projects", projects to promote energy conservation, including but not limited to, energy conserving modification to windows and doors; caulking and weatherstripping; combined heat and power facilities; insulation; automatic energy control systems; hot water systems; equipment required to operate variable steam, hydraulic and ventilating systems; plant and distribution system modifications including replacement of burners, furnaces or boilers; devices for modifying fuel openings; electrical or mechanical furnace ignition systems; utility plant system conversions; replacement or modification of lighting fixtures; energy recovery systems; and cogeneration systems.

"Energy efficiency", the implementation of an action, policy or measure which entails the application of the least amount of energy required to produce a desired or given output.

B-339

“Energy management services”, a program of services, including energy audits, energy conservation measures, energy conservation projects or a combination thereof, and building maintenance and financing services, primarily intended to reduce the cost of energy and water in operating buildings, which may be paid for in whole or in part, by cost savings attributable to a reduction in energy and water consumption which result from such services.

“FERC”, the federal energy regulatory commission.

“Gas company”, a corporation organized for the purpose of making and selling or distributing and selling, gas within the commonwealth, even though subsequently authorized to make or sell electricity; provided, however, that gas company shall not mean an alternative energy producer.

“Generation”, the act or process of transforming other forms of energy into electric energy or the amount of electric energy so produced.

“Generation company”, a company engaged in the business of producing, manufacturing or generating electricity or related services or products, including but not limited to, renewable energy generation attributes for retail sale to the public.

“Generation facility”, a plant or equipment used to produce, manufacture or otherwise generate electricity and which is not a transmission facility.

“Generation service”, the provision of generation and related services to a customer.

“Green building”, a building, including but not limited to, homes, offices, schools, and hospitals constructed or renovated to incorporate design techniques, technologies, and materials that lessen its dependence on fossil fuels and minimize its overall negative environmental impact.

“Horizontal market power”, a situation in which 1 or a few market participants combined have undue concentration in the ownership of facilities at the same level in the chain of production resulting in the ability to influence price to his or their own benefit.

“ ISO -NE”, the independent system operator for New England .

“Mitigation”, all actions or occurrences which reduce the amount of money that a distribution company seeks to collect through the transition charge, including those amounts resulting from both matters within the company's control and from matters not wholly within the company's control; provided, however, that mitigation shall, in accordance with section 1G, include, but not be limited to, the following: (1) sales of capacity, energy, ancillary services, reserves, and emission allowances from generating facilities that are wholly or partly owned by the company; (2) sales of capacity, energy, ancillary services, reserves and emission allowances from generating facilities with which the

B-340

company has a power purchase agreement; (3) adjustments to the company's minimum obligations under purchase power agreements that decrease such obligations, such as those that may be obtained through contract buy-out or renegotiation; (4) residual value; (5) sales and voluntary write downs of company generation-related assets; (6) any market value in excess of net book value associated with the sale, lease, transfer or other use of the assets of the company unrelated to the provision of transmission service or distribution service at regulated prices, including, but not limited to, rights-of-way, property and intangible assets when the costs associated with the acquisition of those assets have been reflected in the company's rates for regulated service; provided, however, that the department of public utilities shall determine the market values based on the highest prices that such assets could reasonably realize after an open and competitive sale; and (7) any allowed refinancing of stranded assets or other debt obligations as provided by law.

"Non-renewable energy supply and resource development", shall include, but shall not be limited to, gasoline, natural gas, coal, nuclear energy, offshore and onshore petroleum and facilities related to the exploration, development, processing, transportation and distribution of such resources and programs established for the allocation of supplies of such resources and the development of supply shortage contingency plans.

"Petroleum products", propane, gasoline, unleaded gasoline, kerosene, #2 heating oil, diesel fuel, kerosene base jet fuel, and #4, 5 and 6 residual oil for utility and non-utility uses, and all petroleum derivatives, whether in bond or not, which are commonly burned to produce heat, power, electricity or motion or which are commonly processed to produce synthetic gas for burning.

"Primary energy source", fuels used, except during periods of maintenance or repair, for the generation of electric energy; provided, however, that primary energy source shall not include the minimum amounts of fuel required for ignition, start-up, testing, flame stabilization, and control uses, and minimum amounts of fuel required to alleviate or prevent unanticipated equipment outages and emergencies declared by the governor, directly affecting the public health, safety and welfare which would result from electric power outages.

"Renewable energy", (i) resources whose common characteristic is that they are nondepletable or are naturally replenishable but flow-limited; or (ii) existing or emerging non-fossil fuel energy sources or technologies, which have significant potential for commercialization in New England and New York, and shall include the following: solar photovoltaic or solar thermal electric energy; wind energy; ocean thermal, wave, or tidal energy; geothermal; fuel cells; landfill gas; waste-to-energy which is a component of conventional municipal solid waste plant technology in commercial use; naturally flowing water and hydroelectric; and low emission advanced biomass power conversion technologies using such fuels such as wood, by-products or waste from agricultural crops, food or animals, energy crops, biogas, liquid biofuel including but not limited to biodiesel, organic refuse-derived fuel, or algae; provided, however, that renewable energy supplies shall not include coal, oil, natural gas except when used in fuel cells, and nuclear power.

B-341

“Reseller”, a person, corporation, firm or subsidiary of any firm that carries on the trade or business of purchasing petroleum products and reselling them without substantially changing their form, or any wholesaler or retail seller of electricity or natural gas.

“Residual value”, the value of electric company assets, not including the income which may be obtained through generation facility operation.

“Retail access”, the use of transmission and distribution facilities owned by a transmission company or a distribution company to transmit or distribute electricity from a generation company, supplier or aggregator to retail customers.

“Retail customer”, a customer who purchases electricity for its own consumption.

“Securitization”, the use of rate reduction bonds to refinance debt and equity associated with transition costs under section 1H.

“Service territory”, the geographic area in which a distribution company provided distribution service on July 1, 1997 .

“Small power production facility”, a facility which is any electrical generating unit which produces electric energy solely by the use, as a primary energy source, of biomass, waste, wind, water, wood, geothermal, solar energy or any combination thereof, or produces gas if it is produced from coal, biomass, solid waste or wood, and has a power production capacity which, together with any other facilities located at the same site, is not greater than 30 megawatts.

“Steam distribution company”, a person, firm, partnership, association or private corporation organized or operating under the laws of the commonwealth with the primary purpose of operating a plant, equipment or facilities for the manufacture, production, transmission, furnishing or distribution of steam to or for the public for compensation within the commonwealth; provided, however, that steam distribution company shall not include: (i) an entity producing or distributing steam exclusively on private property and solely for use by the entity or the entity's tenant, and not for distribution or sale; or (ii) a company that produces and sells steam as a by-product of the production of electricity for sale in the wholesale electricity markets and does not own or operate pipelines off site of the generating facility for the distribution of steam.

“Supplier”, a supplier of generation service to retail customers, including power marketers, brokers and marketing affiliates of distribution companies, except that no electric company shall be considered a supplier.

B-342

“Supplying electricity in bulk”, engaging in the business of making and selling or distributing and selling electricity to electric companies, railroads, street railways or electric railroads, or to municipalities for municipal use or re-sale to their inhabitants, or to persons, associations or corporations under limitations imposed by special law or under section 90 or corresponding provisions of earlier laws.

“Transition charge”, the charge that provides the mechanism for recovery of an electric company's transition costs.

“Transition costs”, the embedded costs as determined under section 1H which remain after accounting for maximum possible mitigation, subject to determination by the department of public utilities.

“Transmission”, the delivery of power over lines that operate at a voltage level typically equal to or greater than 69,000 volts from generating facilities across interconnected high voltage lines to where it enters a distribution system.

“Transmission company”, a company engaging in the transmission of electricity or owning, operating or controlling transmission facilities; provided, however, that a transmission company shall provide transmission service to all generation companies, municipal lighting plants, suppliers and load aggregators in the commonwealth, whether affiliated or not, on comparable, nondiscriminatory prices and terms, under federal law and regulation.

“Transmission facility”, plant or equipment used for the transmission of electricity, as determined by the FERC under federal law and regulation.

“Transmission service”, the delivery of electricity to a retail customer, supplier, distribution company or wholesale customer by a transmission company.

“Unbundled rates”, rates designed to separate the costs of providing generation, the costs of transmission and distribution services, and transition and general access charges.

“Vertical market power”, a situation in which 1 or a few market participants, having joint ownership of facilities at differing levels of the chain of production, such as generation, transmission and distribution, possess the ability to use such joint ownership to influence price to his or their own benefit.

“Wholesaler”, a person, corporation, firm or any part or subsidiary of any firm which supplies, sells, transfers or otherwise furnishes petroleum products to resellers or end-users.

“Wholesale generation company”, a company engaged in the business of producing,

B-343

manufacturing or generating electricity for sale at wholesale only.

SECTION 58. Said section 1A of said chapter 164, as appearing in the 2006 Official Edition, is hereby amended by adding the following subsection:-

(f) Neither this section nor sections 1B to 1H, inclusive, shall preclude an electric company or a distribution company from constructing, owning and operating generation facilities that produce solar energy; provided, however, that such company shall not own or operate more than 25 megawatts of such facilities before January 1, 2009 , and 50 megawatts of such a facility after January 1, 2010 . No electric company or distribution company may recover costs associated with the construction of a generating facility producing solar energy without obtaining prior approval for the costs from the department. Upon the filing by an electric company or a distribution company of a petition for pre-approval of cost recovery for a solar energy generating facility, the department shall determine whether the proposal is consistent with the commonwealth's energy policy and could be used to satisfy, in part, the renewable energy portfolio standard requirements set forth in section 11F of chapter 25A. The department shall issue an order within 6 months after the date of filing by the electric company or distribution company. The department may adopt such rules and regulations as may be necessary to implement this subsection.

SECTION 59. Subsection (f) of section 1A of chapter 164 of the General Laws is hereby repealed.

SECTION 60. Section 1D of said chapter 164, as so appearing, is hereby amended by adding the following 3 paragraphs:-

Residential or small commercial customers: (a) initiating new utility service; (b) reinstating service following a change of residence or business location; (c) making an inquiry regarding their rates; or (d) seeking information regarding energy efficiency shall be offered the option to learn about their ability to enroll with a participating non-utility competitive supplier of energy. Customers expressing an interest in learning about their electric supply options shall be informed of offers available by participating non-utility competitive suppliers. The electric distribution company shall describe then available offers available through a method approved by the department.

Participating non-utility competitive suppliers of energy may list qualifying electric offers to provide electric generation service to residential and small commercial customers in each customer’s utility bill. The department shall determine the manner such information is presented in customers’ utility bills.

For electric suppliers who have chosen the complete billing method, the electric distribution company shall make timely payments to such suppliers in accordance with this paragraph. The distribution company shall: (a) bill all of the electric supplier’s customers in a service class according to

B-344

complete billing; (b) pay such suppliers the full amounts due from customers for generation services in a time period consistent with the average payment period of the participating class of customer, less a percentage of such amounts that reflects the average of the uncollectible bills for the participating customer classes of the electric distribution company and other reasonable development, operating or carrying costs incurred, as approved by the department.

SECTION 61. Subsection (c) of section 1E of said chapter 164, as so appearing, is hereby amended by striking out, in line 34, the figure "2" and inserting in place thereof the following figure:- 2.5.

SECTION 62. Section 1F of said chapter 164, as so appearing, is hereby amended by striking out, in line 90, the word "division" and inserting in place thereof the following word:- department.

SECTION 63. Subparagraph (i) of paragraph (4) of section 1F of said chapter 164, as so appearing, is hereby amended by striking out the second paragraph.

SECTION 64. Said paragraph (4) of said section 1F of said chapter 164, as so appearing, is hereby further amended by striking out subparagraphs (ii) and (iii) and inserting in place thereof the following subparagraph:-

(ii) A residential customer eligible for low-income discount rates shall receive the service on demand. Each distribution company shall periodically notify all customers of the availability and method of obtaining low-income discount rates. An existing residential customer eligible for a low-income discount on the date of the start of retail access who orders service for the first time from a distribution company shall be offered basic service by that distribution company.

SECTION 65. Section 1G of said chapter 164, as so appearing, is hereby amended by striking out, in lines 366 and 367, the words "government regulations" and inserting in place thereof the following words:- telecommunications, utilities and energy.

SECTION 66. Section 47C of said chapter 164, as so appearing, is hereby amended by adding the following subsection:-

(l) The activities of a municipal lighting plant cooperative shall not be imputed to its individual members and the provision of energy brokering and other energy-related services by a municipal lighting plant cooperative to retail customers without any accompanying sale of electricity to such retail customers shall not constitute the supply of generation services by its members for the purposes of subsection (b) of section 47A.

SECTION 67. Section 76D of said chapter 164, as so appearing, is hereby amended by inserting after the word "companies", in lines 1 and 2, in line 14, the third time it appears, and in line 20, the

B-345

second time it appears, the following words:- , steam distribution companies.

SECTION 68. Said section 76D of said chapter 164, as so appearing, is hereby amended by inserting after the word “company”, in line 9, the following words:- , steam distribution company.

SECTION 69. Said chapter 164 is hereby further amended by striking out section 96, as so appearing, and inserting in place thereof the following section:-

Section 96. Companies, except steam distribution companies, subject to this chapter and their holding companies may, notwithstanding any other provisions of this chapter or of any general or special law, consolidate or merge with one another, or may sell and convey their properties to another of such companies or to a wholesale generation company and such other company may purchase such properties if such purchase, sale, consolidation or merger, and the terms thereof, have been approved, at meetings called therefor, by vote of the holders of at least two-thirds of each class of stock outstanding and entitled to vote on the question of each of the contracting companies, and that the department, after notice and a public hearing, has determined that such purchase and sale or consolidation or merger, and the terms thereof, are consistent with the public interest; provided, however, that in making such a determination the department shall at a minimum consider: proposed rate changes, if any; the long term strategies that will assure a reliable, cost effective energy delivery system; any anticipated interruptions in service; or other factors which may negatively impact customer service; and provided further, that the purchase or sale of properties by, or the consolidation or merger of, wholesale generation companies shall not require departmental approval.

SECTION 70. Section 116 of said chapter 164, as so appearing, is hereby amended by inserting after the word “secretary”, in line 2, the following words:- or municipal lighting plant manager.

SECTION 71. Said section 116 of said chapter 164, as so appearing, is hereby further amended by inserting after the word “removal,”, in lines 11 and 12, the following words:- the gas or electric company employing.

SECTION 72. Said section 116 of said chapter 164, as so appearing, is hereby further amended by striking out, in line 16, the word “such” and inserting in place thereof the following words:- a duly authorized.

SECTION 73. Said section 116 of said chapter 164, as so appearing, is hereby further amended by adding the following sentence:- A gas or electric company may direct a duly authorized employee to restore meters, pipes, wires, fittings, works or service, consistent with the local bargaining agreement entered into by the company and the local bargaining unit to which the employee belongs.

SECTION 74. Section 134 of said chapter 164, as so appearing, is hereby amended by striking out, in lines 31, 51 and 75, the word “division” and inserting in place thereof, in each instance, the

B-346
following word:- department.

SECTION 75. The fourth paragraph of section 134 of said chapter 164, as so appearing, is hereby amended by striking out the last sentence.

SECTION 76. Said section 134 of said chapter 164, as so appearing, is hereby further amended by striking out, in lines 56 and 64, the words “standard offer” and inserting in place thereof, in each instance, the following word:- basic.

SECTION 77. Said section 134 of said chapter 164, as so appearing, is hereby further amended by striking out, in line 74, the words “standard offer” and inserting in place thereof the following words:- basic service.

SECTION 78. Said chapter 164 is hereby further amended by adding the following 6 sections:-

Section 138. As used in this section and sections 139 and 140, the following words shall, unless the context otherwise requires, have the following meanings:-

“Agricultural net metering facility”, a renewable energy generating facility operated as part of an agricultural business that generates electricity that does not have a generation capacity of more than 2 megawatts and is located on land owned or controlled by the agricultural business and is used to provide energy to metered accounts of the business.

“Agriculture”, the same meaning as provided in section 1A of chapter 128; provided, however, that when necessary, the commissioner of agricultural resources shall determine if a business is an agricultural business.

“Class I net metering credit”, a credit equal to the excess kilowatt-hours by time of use billing period, if applicable, multiplied by the sum of the distribution company’s: (i) default service kilowatt-hour charge in the ISO -NE load zone where the customer is located; (ii) distribution kilowatt-hour charge; (iii) transmission kilowatt-hour charge; and (iv) transition kilowatt-hour charge; provided, however, that this shall not include the demand side management and renewable energy kilowatt-hour charges set forth in sections 19 and 20 of chapter 25; and provided further, that credit for a Class I net metering facility not using solar or wind as its energy source shall be the average monthly clearing price at the ISO -NE.

“Class I net metering facility”, a plant or equipment that is used to produce, manufacture or otherwise generate electricity and that is not a transmission facility and that has a design capacity of 60 kilowatts or less.

“Class II net metering credit”, a credit equal to the excess kilowatt-hours by time of use billing period, if applicable, multiplied by the sum of the distribution company’s: (i) default service kilowatt-

hour charge in the ISO -NE load zone where the customer is located; (ii) distribution kilowatt-hour charge; (iii) transmission kilowatt-hour charge; and (iv) transition kilowatt-hour charge; provided, however, that this shall not include the demand side management and renewable energy kilowatt-hour charges set forth in sections 19 and 20 of chapter 25.

"Class II net metering facility", an agricultural net metering facility, solar net metering facility, or wind net metering facility with a generating capacity of more than 60 kilowatts but less than or equal to 1 megawatt; provided, however, that a Class II net metering facility owned or operated by a customer which is a municipality or other governmental entity may have a generating capacity of more than 60 kilowatts but less than or equal to 1 megawatt per unit.

"Class III net metering credit", a credit equal to the excess kilowatt-hours by time of use billing period, if applicable, multiplied by the sum of the distribution company's: (i) default service kilowatt-hour charge in the ISO -NE load zone where the customer is located; (ii) transmission kilowatt-hour charge; and (iii) transition kilowatt-hour charge; provided, however, that if a customer is a municipality or other governmental entity, the credit shall be equal to the excess kilowatt-hours multiplied by the sum of (i), (ii) and (iii) and the distribution kilowatt-hour charge; and provided further, that this shall not include the demand side management and renewable energy kilowatt-hour charges set forth in sections 19 and 20 of chapter 25.

"Class III net metering facility", an agricultural net metering facility, solar net metering facility, or wind-net-metering facility with a generating capacity of more than 1 megawatt but less than or equal to 2 megawatts; provided, however, that a Class III net metering facility owned or operated by a customer which is a municipality or other governmental entity may have a generating capacity of more than 1 megawatt but less than or equal to 2 megawatts per solar net metering or wind net metering unit.

"Customer", a customer of a distribution company that is entitled to the net metering credits, including net metering facilities.

"Neighborhood", a geographic area including and limited to a unique community of interests that is recognized as such by residents of such area and which, in addition to residential and undeveloped properties, may encompass commercial properties.

"Neighborhood net metering credit", a credit equal to the excess kilowatt-hours by time of use billing period, if applicable, multiplied by the sum of the distribution company's: (i) default service kilowatt-hour charge in the ISO -NE load zone where the customer is located; (ii) transmission kilowatt-hour charge; and (iii) transition kilowatt-hour charge; provided, however, that this shall not include the demand side management and renewable energy kilowatt-hour charges set forth in sections 19 and 20 of chapter 25.

B-348

“Neighborhood net metering facility”, a Class I, II or III net metering facility that: (i) is owned by, or serves the energy needs of, a group of 10 or more residential customers that resides in a single neighborhood and is served by a single distribution company; and (ii) is located within the same neighborhood as the customers that own or are served by the facility.

“Net metering”, the process of measuring the difference between electricity delivered by a distribution company and electricity generated by a Class I, Class II, Class III or neighborhood net metering facility and fed back to the distribution company.

“Renewable energy”, energy generated from any source that qualifies as a Class I or Class II renewable energy generating source under section 11F of chapter 25A; provided, however, that after conducting administrative proceedings, the department of energy resources, in consultation with the department of agriculture, may add technologies or technology categories.

“Solar net metering facility”, a facility for the production of electrical energy that uses sunlight to generate electricity and is interconnected to a distribution company.

“Wind net metering facility”, a facility for the production of electrical energy that uses wind to generate electricity and is interconnected to a distribution company.

Section 139. (a) A distribution company customer that uses electricity generated by a Class I or Class II net metering facility may elect net metering as follows:

(1) If the electricity generated by the Class I or Class II net metering facility during a billing period exceeds the customer’s kilowatt-hour usage during the billing period, the customer shall be billed for 0 kilowatt-hour usage and the excess Class I or Class II net metering credits shall be credited to the customer’s account. Credits may be carried forward from month to month. A Class I or Class II wind or solar net metering facility may designate customers of the same distribution company to which the Class I or Class II wind or solar net metering facility is interconnected and that are located in the same ISO -NE load zone to receive such credits in amounts attributed by the Class I or Class II wind or solar net metering facility. Written notice of the identities of the customers so designated and the amounts of the credits to be attributed to such customers shall be in a form as the distribution company shall reasonably require.

(2) If the customer’s kilowatt-hour usage exceeds the electricity generated by the Class I or Class II net metering facility during the billing period, the customer shall be responsible for the balance at the distribution company’s applicable rate.

(b) A distribution company customer that uses electricity generated by a Class III net metering facility may elect net metering as follows:

B-349

(1) If the electricity generated by the Class III net metering facility during a billing period exceeds the customer's kilowatt-hour usage during the billing period, the customer shall be billed for 0 kilowatt-hour usage and the excess Class III net metering credits shall be credited to the customer's account. Credits may be carried forward from month to month. A Class III net metering facility may designate customers of the same distribution company to which the Class III net metering facility is interconnected and that are located in the same ISO -NE load zone to receive such credits in amounts attributed to such customers by the Class III net metering facility. Written notice of the identities of the customers so designated and the amounts of the credits to be attributed to such customers shall be in a form as the distribution company shall reasonably require. A distribution company may elect not to allocate such credits and instead may purchase net metering credits from the facility at the rates provided for in this subsection.

(2) If the customer's kilowatt-hour usage exceeds the electricity generated by the Class III net metering facility during the billing period, the customer shall be responsible for the balance at the distribution company's applicable rate.

(c) The distribution portion of any Class I, Class II or Class III net metering credits and distribution company delivery charges displaced by a Class I, Class II or Class III net metering facility shall be aggregated by the distribution company and billed to all customers on an annual basis through a uniform per kilowatt-hour surcharge or surcharges.

(d) The distribution company shall impose tariffs, as may be approved from time to time by the department, regarding necessary interconnection studies and the type, costs and timeframe for installing metering and distribution system upgrades to accommodate these installations. Such tariffs shall require that all facilities maintain adequate insurance. Distribution companies shall be prohibited from imposing special fees on Class I net metering facilities, such as backup charges and demand charges, or additional controls or liability insurance, as long as the facility meets the other requirements of the interconnection tariff and all relevant safety and power quality standards.

Before providing net metering service under this section, a Class II or III net metering facility shall provide all necessary information to, and cooperate with, the distribution utility to which it is interconnected to enable the distribution utility to obtain the appropriate asset identification for reporting generation to ISO -NE.

(e) A Class I, II or III net metering facility or net metering customer shall not be: an electric utility, generation company, aggregator, supplier, energy marketer or energy broker, within the meaning of those terms as defined in sections 1 and 1F.

(f) The aggregate capacity of net metering shall not exceed 1 per cent of the distribution company's peak load. For the purpose of calculating the aggregate capacity, the capacity of a solar net metering facility shall be 80 per cent of the facility's direct current rating at standard test conditions

B-350

and the capacity of a wind net metering facility shall be the nameplate rating.

(g) The department shall adopt rules and regulations necessary to carry out this section.

Section 140. A neighborhood net metering facility shall elect net metering as follows:

(a) If the electricity generated by the neighborhood net metering facility during a billing period exceeds its kilowatt-hour usage during the billing period, the neighborhood net metering facility shall be billed for 0 kilowatt-hour usage and the excess neighborhood net metering credits shall be credited to those customers identified by the neighborhood net metering facility as being served by the same company to which the neighborhood net metering facility is interconnected, residing in the same neighborhood in which the neighborhood net metering facility is located and having an ownership interest in the neighborhood net metering facility. The amount of the excess neighborhood net metering credits to be attributed to each such customer shall be determined by the allocation provided by the neighborhood net metering facility. Credits may be carried forward by such customers from month to month. Written notice of the identity of the customers so designated and the allocation of the credits to be attributed to such customers shall be in such form as the distribution company shall reasonably require.

(b) The department shall adopt rules and regulations necessary to carry out this section, including, but not limited to, further defining the term “neighborhood” and limiting the number of customers that may be designated by neighborhood net metering facilities to receive neighborhood net metering credits.

Section 141. In all decisions or actions regarding rate designs, the department shall consider the impacts of such actions, including the impact of new financial incentives on the successful development of energy efficiency and on-site generation. Where the scale of on-site generation would have an impact on affordability for low-income customers, a fully compensating adjustment shall be made to the low-income rate discount.

Section 142. The department shall continue to remove any impediments to the development of efficient, low-emissions distributed generation, including combined heat and power, taking into account the need to appropriately allocate any associated costs in a fair and equitable manner. For the purposes of this section, “efficient, low-emissions” shall mean an efficiency of 60 per cent or greater on an annual basis and emissions lower than required by the department of environmental protection.

Section 143. (a) For the purposes of this section, the term “small municipal renewable energy generating facility” shall mean a generating unit that is designed for, or capable of, operating at a gross capacity of less than 10 megawatts and that qualifies as a Class I renewable energy generating source under section 11F of chapter 25A.

B-351

(b) Notwithstanding any general or special law to the contrary, a municipality may design, install, own and operate small municipal renewable energy generating facilities, sell any electricity generated from such facilities and sell any other marketable products resulting from its generation of renewable energy at such facilities, including electronic certificates created to represent the generation attributes, as defined in 225 CMR 14.02, of each megawatt hour of energy generated by the renewable energy facilities; provided, however, that no later than 15 days after the initiation of a procurement of services, equipment or materials related to a small municipal renewable energy generating facility and again no later than 15 days after the date that such small municipal renewable energy generating facility first produces electrical energy, said municipality shall submit a report to the department of public utilities and the department of energy resources detailing the costs of the small municipal renewable energy generating facility and a plan and forecast for the disposition of the facility's products. The department of energy resources shall annually issue a report containing information on small municipal renewable energy generating facilities, including the number, capacity, production and performance of such facilities and recommendations, if any, for additional legislative action to increase the benefits available to municipalities through ownership of renewable energy generating facilities. The department of energy resources shall submit such report, including drafts of legislation to implement recommendations within such report, to the joint committee on telecommunications, utilities and energy and the senate and house committees on ways and means not later than April 30 of each year.

(c) A municipality may issue from time to time bonds or notes in order to finance all or a portion of the costs of small municipal renewable energy generating facility projects authorized under this section. Notwithstanding any provision of chapter 44 to the contrary, the maturities of any such bonds issued by a municipality hereunder either shall be arranged so that for each issue the annual combined payments of principal and interest payable in each year, commencing with the first year in which a principal payment is required, shall be as nearly equal as practicable in the opinion of the municipal treasurer or shall be arranged in accordance with a schedule providing for a more rapid amortization of principal. The first payment of principal of each issue of bonds or of any temporary notes issued in anticipation of the bonds shall be not later than 5 years after the anticipated date of commencement of the regular operation of the small municipal renewable energy generating facilities financed thereby, as determined by the municipal treasurer, and the last payment of principal of the bonds shall be not later than 25 years from the date of the bonds. Indebtedness incurred under this section shall not be included in determining the limit of indebtedness of a municipality under section 10 of said chapter 44 but, except as otherwise provided in this subsection, shall be subject to the provisions of said chapter 44.

(d) A municipality shall procure any services required for the design, installation, improvement, repair and operation of small municipal renewable energy generating facilities authorized under this section, and acquire any equipment necessary in connection therewith, in accordance with the procurement requirements of chapter 30B as applicable. A municipality may procure any such services and equipment together as 1 procurement or as separate procurements thereunder.

B-352

(e) A municipality may establish an enterprise fund under section 53F1/2 of chapter 44 for the receipt of all revenues from the operation of small municipal renewable energy generating facilities authorized under this section to operate and all moneys received for the benefit of such small municipal renewable energy generating facilities, other than the proceeds of bonds or notes issued therefor. Such receipts shall be used to pay the costs of operation and maintenance of the small municipal renewable energy generating facilities, to pay the costs of future improvements and repairs thereto and to pay the principals and interest on any bonds or notes issued therefor.

SECTION 79. The General Laws are hereby further amended by inserting after chapter 164A the following chapter:-

CHAPTER 164B.

REGULATION OF STEAM DISTRIBUTION COMPANIES.

Section 1. For purposes of this chapter, the term “department” shall refer to the department of public utilities. The department shall have supervision of facilities operated by steam distribution companies for the sole purpose of ensuring public safety and shall establish reasonable rules and regulations pertaining to the construction and operation of steam distribution facilities and equipment used in manufacturing and transporting steam. The department shall keep itself informed as to the methods, practices, and condition of all facilities and equipment associated with the distribution of steam, including ducts and conduits, and shall make such examinations and investigations of the steam distribution system as necessary, including the adequacy of operation, maintenance and capital improvements to insure safe operation of facilities operated by a steam distribution company.

Section 2. Each steam distribution company shall file a certified copy of its certificate of incorporation and bylaws with the department. By March first of each year each company shall file a report on safety related matters as the department may specify, including but not limited to number, duration and causes of all steam leakage incidents, distribution system accidents and service outages, time elapsed between the incident and the return to service following a repair. The department may levy fines against a steam distribution company for failure to comply with regulations promulgated by the department. In determining the appropriateness of any fine, the department shall consider the seriousness of the violation and the good faith compliance efforts of the steam distribution company.

Section 3. The department shall provide written notice to the attorney general of any violation of this chapter. The department’s authority shall not diminish the authority of any municipality to regulate steam distribution, nor shall it diminish the authority of the department of public safety under chapter 146.

Section 4. Any entity operating a steam distribution system that does not meet the definition of a steam distribution company set forth in section 1 of chapter 164 shall be exempt from the

B-353

requirements of this chapter and section 18A of chapter 25 if the entity files a detailed inspection and maintenance plan with the department every 2 years.

SECTION 80. Section 17B of chapter 271 of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by striking out, in lines 4 and 5, the words “energy, as defined in paragraph (d) of section twelve of chapter one hundred and fifty-nine” and inserting in place thereof the following words:- cable or the department of public utilities.

SECTION 81. Section 22 of chapter 140 of the acts of 2005 is hereby amended by striking out the words “11C of chapter 25” and inserting in place thereof the following words:- 11I of chapter 25A.

SECTION 82. Section 23 of said chapter 140 is hereby amended by striking out the words “11C of chapter 25” and inserting in place thereof the following words:- 11I of chapter 25A.

SECTION 83. Commencing on July 1, 2009 , and continuing for a period of 5 years thereafter, each distribution company, as defined in section 1 of chapter 164 of the General Laws, shall be required twice in that 5 year period to solicit proposals from renewable energy developers and, provided reasonable proposals have been received, enter into cost-effective long-term contracts to facilitate the financing of renewable energy generation within the jurisdictional boundaries of the commonwealth, including state waters, or in adjacent federal waters. Distribution companies may also voluntarily solicit additional proposals over the 5 year period. The timetable and method for solicitation and execution of such contracts shall be proposed by the distribution company in consultation with the department of energy resources and shall be subject to review and approval by the department of public utilities. This long-term contracting obligation shall be separate and distinct from the electric distribution companies’ obligation to meet applicable annual renewable portfolio standard, hereinafter referred to as RPS, requirements, set forth in section 11F of chapter 25A of the General Laws.

For purposes of this section, a long-term contract is defined as a contract with a term of 10 to 15 years. In developing the provisions of proposed long term contracts, the distribution company shall consider multiple contracting methods, including long-term contracts for renewable energy certificates, hereinafter referred to as RECs, for energy, and for a combination of both RECs and energy. The electric distribution company shall select a reasonable method of soliciting proposals from renewable energy developers, which may include public solicitations, individual negotiations or other methods. The distribution company may decline to consider contract proposals having terms and conditions that it determines would require the contract obligation to place an unreasonable burden on the distribution company’s balance sheet. The distribution company shall consult with the department of energy resources regarding its choice of contracting methods and solicitation methods. All proposed contracts shall be subject to the review and approval of the department of public utilities.

The department of public utilities and the department of energy resources each shall adopt regulations consistent with this section. The regulations shall: (a) allow renewable energy developers

B-354

to submit proposals for long-term contracts conforming to the contracting methods specified in the second paragraph; (b) require that contracts executed by the distribution company under such proposals are filed with, and approved by, the department of public utilities before they become effective; (c) provide for an annual remuneration for the contracting distribution company equal to 4 per cent of the annual payments under the contract to compensate the company for accepting the financial obligation of the long-term contract, such provision to be acted upon by the department of public utilities at the time of contract approval; and (d) require that the renewable energy generating source to be used by a developer under the proposal meet the following criteria: (1) have a commercial operation date, as verified by the department of energy resources, on or after January 1, 2008; (2) be qualified by the department of energy resources as eligible to participate in the RPS program, under said section 11F of chapter 25A, and to sell RECs under the program; and (3) be determined by the department of public utilities to: (i) provide enhanced electricity reliability within the commonwealth; (ii) contribute to moderating system peak load requirements; (iii) be cost effective to Massachusetts electric ratepayers over the term of the contract; and (iv) where feasible, create additional employment in the commonwealth. As part of its approval process, the department of public utilities shall consider the attorney general's recommendations, which shall be submitted to the department of public utilities within 45 days following the filing of such contracts with the department of public utilities. The department of public utilities shall take into consideration both the potential costs and benefits of such contracts, and shall approve a contract only upon a finding that it is a cost effective mechanism for procuring renewable energy on a long-term basis.

Distribution companies shall not be obligated to enter into long-term contracts under this section that would, in the aggregate, exceed 3 per cent of the total energy demand from all distribution customers in the service territory of the distribution company. As long as the electric distribution company has entered into long term contracts in compliance with this section, it shall not be required by regulation or order to enter into contracts with terms of more than 3 years in meeting its applicable annual RPS requirements set forth in said section 11F of said chapter 25A, unless the department of public utilities finds that such contracts are in the best interest of customers; provided, however, that the electric distribution company may execute such contracts voluntarily, subject to the department of public utilities' approval.

An electric distribution company may elect to use any energy purchased under such contracts for resale to its customers, and may elect to retain RECs for the purpose of meeting the applicable annual RPS requirements set forth in said section 11F of said chapter 25A. If the energy and RECs are not so used, such companies shall sell such purchased energy into the wholesale spot market and shall sell such purchased RECs through a competitive bid process. Notwithstanding the foregoing, the department of energy resources shall conduct periodic reviews to determine the impact on the energy and REC markets of the disposition of energy and RECs hereunder, and may issue reports recommending legislative changes if it determines that actions are being taken that will adversely affect the energy and REC markets.

B-355

If the distribution company sells the purchased energy into the wholesale spot market and auctions the RECs as described in the fifth paragraph, the distribution company shall net the cost of payments made to projects under the long-term contracts against the proceeds obtained from the sale of energy and RECs, and the difference shall be credited or charged to all distribution customers through a uniform fully reconciling annual factor in distribution rates, subject to review and approval of the department of public utilities. The reconciliation process shall be designed so that the distribution company recovers all costs incurred under such contracts.

If the RPS requirements of said section 11F of said chapter 25A should ever terminate, the obligation to continue periodic solicitations to enter into long term contracts shall cease, but contracts already executed and approved by the department of public utilities shall remain in full force and effect.

On or before July 1, 2010 , and annually until the long-term contracting requirement expires, the department of energy resources shall assess whether the long-term contracting requirements set forth in this section reasonably support the renewable energy goals of the commonwealth as set forth in said section 11F of said chapter 25A, and whether the alternative compliance rate established under said section 11F should be adjusted accordingly.

The provisions of this section shall not limit consideration of other contracts for RECs or power submitted by a distribution company for review and approval by the department of public utilities.

If any provision of this section is subject to a judicial challenge, the department of public utilities may suspend the applicability of the challenged provision during the pendency of the judicial action until final resolution of the challenge and any appeals, and shall issue such orders and take such other actions as are necessary to ensure that the provisions that are not challenged are implemented expeditiously to achieve the public purposes of this provision.

SECTION 84. The secretary of energy and environmental affairs shall, in conjunction with the department of public utilities, implement an “energy pay and save”, hereinafter referred to as EPS, pilot program, allowing electric utility customers to purchase and install energy efficient or renewable energy products in their residences or commercial facilities by paying the cost of the system over time through an additional charge on the customer's electricity bill. The cost of the products purchased under the pilot program shall be added to the electric utility customer’s utility bills in a form approved by the department, as a monthly EPS tariff, and shall be paid until the cost of purchase and installation of the products is paid off. The payment structure shall be implemented so that the charge on the electric utility customer’s utility bill shall be less than that customer’s energy savings over the course of each given year. Non-payment by the owner of the EPS tariff shall result in disconnection and a utility shall be entitled to recover the debt.

The pilot program shall be established with a minimum of 50 participants and a maximum of 200

B-356

participants. The maximum project size for the program shall be $1,000 for commercial utility customers and $500 for residential utility customers. Portable electrical cost measures shall not be funded. Quick pay options shall be investigated, allowing customers to have the option to pay off the entire balance of the amount financed on the first billing cycle. The program shall be funded from such sources as determined by the secretary of energy and environmental affairs and such funds shall be used to offset the cost of the program for the utilities, and as such payments for the purchases are paid to said utilities.

The pilot program shall be implemented on or before April 1, 2009 , and shall expire on December 31, 2009 . The secretary and the department shall issue a final report, which shall include the results of its review and analysis, to the joint committee on telecommunications, utilities and energy and the house and senate committees on ways and means on or before July 31, 2010 .

SECTION 85. On or before April 1, 2009 , each electric distribution company shall file a proposed plan with the department of public utilities to establish a smart grid pilot program. Each such pilot program shall utilize advanced technology to operate an integrated grid network communication system in a limited geographic area. Each pilot program shall include, but not be limited to advanced (“smart”) meters that provide real time measurement and communication of energy consumption, automated load management systems embedded within current demand-side management programs and remote status detection and operation of distribution system equipment. On or before April 1, 2009 , each electric distribution company shall file a proposal with the department of public utilities to implement a pilot program that requires time of use or hourly pricing for commodity service for a minimum of 0.25 per cent of the company’s customers. A specific objective of the pilot shall be to reduce, for those customers who actively participate in the pilot, peak and average loads by a minimum of 5 per cent. The department shall work with the electric distribution companies to identify specific areas of study, and may incorporate and utilize information from past relevant studies or pilot programs. The department shall review and approve or modify such plans on or before August 1, 2010 . Plans which provide for larger numbers of customers and can show higher bill savings than outlined above shall be eligible to earn incentives as outlined in an approved plan. The programs filed by the distribution company shall include proposals for rate treatment of incremental program costs; provided, however, that such program costs shall be deemed by the department to be a cost of basic service and recovered in rates charged for basic service. Following the completion of the pilot programs, the secretary of energy and environmental affairs shall submit a report to the joint committee on telecommunications, utilities and energy not later than September 1, 2012 detailing the operation and results of such programs, including information concerning changes in consumer’s energy use patterns, an assessment of the value of the program to both participants and non-participants and recommendations concerning modification of the programs and further implementation.

SECTION 86. The department of public utilities shall direct all distribution companies, as defined in section 1F of chapter 164 of the General Laws, to submit a plan within 60 days of the effective date

of this act providing for retail access to competitive sellers of renewable energy generation attributes, whether or not bundled with electricity. The department shall approve or modify such plan after an opportunity for notice and comment by all interested persons and shall ensure that such plan does not provide distribution companies with a market advantage over competitive suppliers of renewable energy generation attributes; provided, however, that if a distribution company provides retail access to competitive sellers of renewable energy generation attributes before the effective date of this act, it shall not be required to file a plan under this section.

SECTION 87. There is hereby established a special commission to consist of 3 members of the senate, 1 of whom shall be the senate chair for the joint committee on telecommunications, utilities and energy who shall serve as co-chair, and 1 of whom shall be appointed by the senate minority leader; 3 members of the house of representatives, 1 of whom shall be the house chair for the joint committee on telecommunications, utilities and energy who shall serve as co-chair, and 1 of whom shall be appointed by the house minority leader; the commissioner of energy resources or a designee; the secretary of energy and environmental affairs or a designee; and 3 persons to be appointed by the governor, 1 of whom shall be a representative of the waste-to-energy industry, and 1 of whom shall be a representative of a consumer advocacy organization, for the purpose of making an investigation and study relative to the burning of construction and demolition waste as it relates to the renewable energy portfolio standard program established by section 11F of chapter 25A of the General Laws. The commission shall report the results of its investigation and study and its recommendations, if any, together with drafts of legislation necessary to carry its recommendations into effect by filing the same with the clerks of the senate and the house of representatives on or before July 1, 2009 .

SECTION 88. There shall be a green building plan commission to examine the environmental and economic impact of establishing a green building plan for the commonwealth. The members of the commission shall be as follows: the commissioner of energy resources or a designee; the director of housing and community development or a designee; the secretary of environmental affairs or a designee; the secretary of administration and finance or a designee; 2 members of the senate, 1 of whom shall be appointed by the senate minority leader; 2 members of the house of representatives, 1 of whom shall be appointed by the house minority leader; the lieutenant governor or a designee, who shall be the chair of the commission; 1 person to be appointed by the Worcester Polytechnic Institute; 1 person to be appointed by the chancellor of the University of Massachusetts at Lowell; 1 person to be appointed by the president of the Massachusetts Institute of Technology; the director of the Massachusetts Technology Collaborative or a designee; 1 person to be appointed by the commissioner of the revenue; 1 person appointed by the Massachusetts Municipal Association; and a representative of the Boston Society of Architects. The chair shall have no vote except in the event of a tie vote. The commission shall file a report of its findings with the clerks of the senate and house of representatives not later than December 31, 2009 .

SECTION 89. There shall be a commission which shall study the siting of energy facilities in the commonwealth. The study shall include, but not be limited to, the following: (a) the development of a

B-358

procedure for coordinating and consolidating applications to construct generating facilities between and among the energy facilities siting board, the department of environmental protection and other appropriate agencies, to enable one-stop shopping for necessary permits or certificates or other appropriate streamlining of the permitting system; (b) the expansion of such coordinated procedures to other energy facilities, if appropriate; (c) possible changes to the energy facilities siting board's procedures for reviewing electric and gas transmission lines in light of recent and proposed changes in the structure and regulation of the electric and gas industries, including regional approaches to the siting of such facilities; (d) clarification of the energy facilities siting board's jurisdiction over the re-powering of existing generating facilities at existing sites and the appropriate standards for reviewing such re-powerings; (e) the development of coordinated procedures to examine the reuse of existing industrial sites for the development of generating facilities; (f) the issue of application fees paid by developers to the energy facilities siting board and the correlation of such fees to the board's procedures, as statutorily revised under this act, in reviewing such applications; provided, however, that the study shall include, but not be limited to, recommendations, if any, on reducing the application fee paid by developers to the board in light of the board's statutorily revised standards of review of such applications under this act; (g) the establishment of a site characterization and suitability commission within the department of environmental protection, which would promulgate criteria to be applied to sites included in an application before the energy facilities siting board and rule on suitability of a proposed site as before the application is approved; and (h) the possibility of requiring applicants to provide either (1) evidence that the proposed facility would employ the best available and most efficient technology to control and reduce water withdrawals, or (2) a description of the environmental impacts, costs and reliability of the water withdrawal method chosen and an explanation of why the proposed technology was chosen; (i) whether current laws and regulations do not adequately facilitate the siting of renewable and alternative energy facilities, or whether they make it more difficult to site renewable energy facilities than fossil-fueled energy facilities, and, if either is the case, to make recommendations for changes to such laws and regulations; and (j) whether renewable and alternative energy generating facilities other than a waste-to-energy facility should be allowed as of right on property zoned for industrial use.

The commission shall consist of the secretary of energy and environmental affairs or a designee, who shall be the chair of the commission; the secretary of housing and economic development or a designee; the commissioner of energy resources or a designee; the commissioner of environmental protection or a designee; the commissioner of conservation and recreation or a designee; the director of coastal zone management or a designee; the director of the department of fish and game or a designee; 1 member of the energy facilities siting board; 3 members of the house of representatives, 1 of whom shall be appointed by the house minority leader; 3 members of the senate, 1 of whom shall be appointed by the senate minority leader; 1 representative of the gas industry; and 2 representatives of ratepayers, 1 of whom shall be appointed by the speaker of the house and 1 of whom shall be appointed by the senate president; and the following members who shall be appointed by the chair of the commission: 1 municipal official to be nominated by the Massachusetts Municipal Association; 2 representatives of environmental organizations, 1 of which shall be a land and water conservation

B-359

organization; 2 representatives of the alternative and renewable energy industry; 1 representative of the electric industry; and 2 representatives to be nominated by the AFL - CIO . The commission shall file a report with its finding, including any legislative and regulatory recommendations, with the clerks of the senate and house of representatives, the joint committee on telecommunications, utilities and energy and the senate and house committees on ways and means not later than 18 months after the effective date of this act.

SECTION 90. The department of energy resources shall establish a pilot program to assist consumers with the purchase of energy efficient items for residential home modifications, hereinafter referred to as the HEAT Loan Program. For the purposes of this program, energy efficient items shall include home insulation, new window installation, advanced programmable thermostats, micro-combined heat and power systems, fuel efficient furnaces, boilers, oil, gas, propane, or electric heating systems; solar, domestic or fuel efficient hot water systems; materials for insulation or sealing of a duct, attic, basement, rim joint or wall; pipe insulation for heating systems; or other retail items for use in a residential dwelling that increase the energy efficiency of the dwelling. In establishing the program, the department shall develop a list of qualified state or federally chartered banking institutions or credit unions that do business in the commonwealth and that are governed by chapter 167 or 171 of the General Laws as participatory lending institutions. For the purposes of this section, a qualified lending institution shall include a lending institution that is certified by the executive office of energy and environmental affairs and which shall offer zero and low interest loans for the purpose of enhancing the energy efficiency of a residential dwelling. The program shall be funded from that portion of the mandatory charge that is authorized by section 19 of chapter 25 of the General Laws and allocated to residential customers. Not less than $5 million shall be made available to assist participating financial institutions in offering these loan products by or through interest rate write downs or other credit enhancement features. Loans offered under the program shall be offered to residential homeowners in the commonwealth solely for the purposes stated in this section.

The department shall make such loans available for purchases made on or after January 1, 2009 , but not later than December 31, 2009 . The department shall establish the rules and guidelines to carry out the purposes of this section, including, but not limited to, establishing applicant criteria, application forms and procedures, energy efficiency product requirements and lending institution tracking and reporting requirements. The department shall submit a report detailing the rules and guidelines and the program results to the joint committee on telecommunications, utilities and energy not later than June 30, 2010 .

SECTION 91. On or before January 1, 2011 , the department of public utilities, in consultation with the department of energy resources, shall file a report on the effectiveness of the programs administered under section 19 of chapter 25 of the General Laws. The report shall include a financial accounting of all funds incurred by and administered under the section, and any recommendations deemed appropriate by the department of public utilities, including but not limited to, the increase, reduction or elimination of any mandatory charges authorized under said section 19 of said chapter 25

B-360

as they may relate to programs and plans under sections 21 and 22 of said chapter 25; provided, however, that any recommendation for reduction or elimination should include a mechanism to ensure continued adequate funding for comprehensive low-income, demand side management and education programs. The report shall be filed with the clerks of the senate and house of representatives, the joint committee on telecommunications, utilities and energy, and the senate and house committees on ways and means.

SECTION 92. The department of public utilities shall hold a public hearing and issue a report, not later than July 1, 2009 , relative to the maintenance and improvements of gate boxes of gas utilities located in the streets, roads or sidewalks. The report shall include, but not be limited to, an evaluation of the frequency of maintenance of gate boxes, the standards and practices employed by gas utilities to determine when maintenance of gate boxes is necessary, existing collaborations and communication between gas utilities and municipalities and state agencies when dealing with gate boxes on municipal and state roadways, and rate impacts and cost benefit analysis. The department shall report its findings, recommendations, any proposed penalties, and legislation, if any to the joint committee on telecommunications, utilities and energy, and the senate and house committees on ways and means.

The department of public utilities shall hold a public hearing and issue a report, not later than July 1, 2009 , relative to maintenance and repair standards for distribution systems of investor-owned electric and gas utilities. The department shall investigate and report on the establishment of performance or prescriptive standards or both that provide for inspection cycles for all overhead and underground facilities designed to minimize or prevent service interruptions and ensure high quality, safe and reliable service through the maintenance of detailed compliance reporting by distribution companies and annual review by the department. The department shall consider cost, local geography and weather, applicable codes, national electric industry practices, sound engineering judgment and experience, and appropriate sanctions, including rate deductions or monetary fines for non-compliance. The department shall report its findings, recommendations and proposed legislation, if any, to the joint committee on telecommunications, utilities and energy, and the senate and house committees on ways and means.

SECTION 93. Notwithstanding any general or special law to the contrary, the department of energy resources shall make available monies from amounts collected through Alternative Compliance Payments established and administered under 225 CMR 14.00 adopted under section 11F of chapter 25A of the General Laws, in the form of grants or other financial incentives for the following: (a) the green communities program established under section 10 of said chapter 25A; (b) state or community colleges in the commonwealth engaged in developing renewable energy generation projects, energy generation demonstration and educational programs, or applied engineering teaching tools pertaining to energy generation; (c) commonwealth-based companies engaged in developing flywheel energy storage technologies; and (d) funding capital investments in new and existing generation units for the use of department of environmental protection approved

beneficial use determination paper derived fuels manufactured by Massachusetts corporations.

SECTION 94. The department of public utilities, in consultation with the department of energy resources, shall review and assess the effects of allowing electric and distribution companies to construct, own or operate solar generation facilities under subsection (f) of section 1A of chapter 164 of the General Laws. This report shall be completed and filed with the joint committee on telecommunications, utilities and energy, and the house and senate committees on ways and means, and the clerks of the senate and house of representatives not later than June 30, 2011 . This report shall include any legislative and regulatory recommendations including but not limited to continuation, expansion or elimination of any provisions of this program under said subsection (f) of said section 1A of said chapter 164.

SECTION 95. The merger or consolidation of holding companies under section 96 of chapter 164 of the General Laws that has been filed and approved by the Federal Energy Regulatory Commission before the effective date of this act shall not be subject to the requirements of said section 96 of said chapter 164.

SECTION 96. The department of energy resources, in consultation with the division of capital asset management and maintenance, shall establish, not later than July 1, 2009 , a methodology for use by agencies in assessing life-cycle costs that includes the requirements and assumptions set forth in subsections (a) and (b) of section 39D of chapter 7 of the General Laws.

SECTION 97. On or before December 31, 2009 , the energy advisory council appointed under section 22 of chapter 25 of the General Laws shall undertake, using third party experts, a study which examines the energy efficiency and demand response programs in the commonwealth, including all public and private funding sources. The study shall include an audit of all existing energy efficiency and demand response programs to identify the costs and benefits associated with such programs. Such third party experts shall not have any contractual relationship with an electric or natural gas distribution company doing business in the commonwealth or any affiliate of such company.

SECTION 98. Not later than September 1, 2009 , the department of public utilities shall establish terms and conditions under which a participating non-utility competitive supplier may be included in the program described in section 1D of chapter 164 of the General Laws.

SECTION 99. The Massachusetts Turnpike Authority shall develop a plan, in consultation with the executive office of transportation and the executive office of energy and environmental affairs, for the availability of alternative fuel at each fueling facility or service terminal on the Massachusetts Turnpike. The plan shall provide for the availability of alternative fuel at such locations not later than January 1, 2014 . If the authority determines that such availability is not feasible for any reason, including the status of leases it has with its tenants on the Massachusetts Turnpike, it shall report those findings, together with the reasons therefor and the status of similar plans or projects of adjacent

states, if any, to the senate and house committees on ways and means and the joint committee on transportation not later than January 31, 2009 .

SECTION 100. (a) The commissioner of energy resources, in consultation with the secretary of administration and finance, the secretary of transportation, the general manager of the Massachusetts Bay Transportation Authority, a representative of the regional transit authorities, the secretary of economic affairs, the secretary of energy and environmental affairs and the operation services division, shall develop a statewide master plan for the advancement of hybrid and alternative fuel vehicles, as defined in section 1 of chapter 90 of the General Laws, and related technology.

(b) The plan shall encompass a 10-year period, beginning in 2010, and shall be divisible in increments of not less than 5 years. The plan shall take into account the geographic diversity of the commonwealth, its present and projected demographics, present and projected transportation needs and infrastructure, and current, emerging and foreseeable alternative fuel and vehicle technologies, and may establish goals for areas such as the purchase and use of hybrid and alternative fuel vehicles, as well as the production, import action or distribution of alternative fuels.

(c) The plan shall identify strategies and corresponding methods of achieving its identified goals together with necessary administration and legislative actions. The plan shall be filed with the clerks of the senate and house of representatives not later than 18 months after the effective date of this act.

SECTION 101. The operational services division, in consultation with the executive office of transportation, the secretary of administration and finance, the department of energy resources, the Massachusetts Bay Transportation Authority and regional transit authorities, shall study the feasibility of developing and implementing a system to facilitate the bulk purchase of alternative fuel vehicles by the commonwealth and its political subdivisions. The study shall include, but shall not be limited to, the potential cost savings to be derived from such a system, the cost of the system administration, appropriate purchasers to participate in the system and the probability of utilization of the system by such purchasers.

The operational services division shall file its findings of the study, and its recommendations, if any, together with drafts of legislation necessary to carry such recommendations into effect, with the clerks of the senate and house of representatives not later then 1 year after the effective date of this act.

SECTION 102. The department of public utilities, in consultation with the department of energy resources, shall hold a public hearing to examine the impacts on the competitive retail electricity marketplace through the existing electric utility default service adjustment mechanism. This public hearing shall include an examination of all costs that are recovered from ratepayers through this charge and recommended changes to insure that appropriate price signals are sent to the marketplace in order for customers to make informed decisions about their energy consumption based

B-363

on price. The department of public utilities shall hold the public hearing not later than May 1, 2009 . The department of public utilities shall file a report of its findings, including any legislative or regulatory recommendations, with the joint committee on telecommunications, utilities and energy and with the clerks of the senate and the house of representatives not later than June 1, 2009 .

SECTION 103. Each electric distribution company under section 1D of chapter 164 of the General Laws shall file a compliance plan, complete with an effective date, indicating its compliance with the last paragraph of said section 1D of said chapter 164 within 3 months after the effective date of this act.

SECTION 104. The first report required to be filed by the division of green communities under subsection (f) of section 10 of chapter 25A shall be filed with the clerks of the senate and the house of representatives, the joint committee on telecommunications, utilities, and energy, and the senate and the house committees on ways and means not later than April 1, 2010 .

SECTION 105. (a) For the purposes of this section, the following words shall, unless the context clearly requires otherwise, have the following meanings:-

“Department”, the department of energy resources.

“Generator”, the person that owns, directly or indirectly, as determined by the department, the output from the renewable energy generating source that is located in the ISO -NE control area, as defined in section 1 of chapter 164 of the General Laws or in a control area adjacent to the ISO -NE control area.

“Person”, an individual, corporation, limited liability company, general or limited partnership, trust, association or other entity, or an agent of such person.

(b) A renewable energy generating source, as defined in subsection (b) of section 11F of chapter 25A of the General Laws, that is physically located in or relocated to a control area adjacent to the ISO -NE control area may qualify as an eligible renewable energy generating source under said section 11F; provided, however, that the renewable energy generated by such renewable energy generating source is delivered into and used by consumers within the ISO -NE control area.

(c) The delivery of renewable energy into the ISO -NE control area, as described in subsection (b), shall not qualify under the renewable portfolio standard, notwithstanding such delivery into the ISO -NE control area, unless the generator of such renewable energy: (1) initiates the import transaction pursuant to a spot market sale into the ISO -NE administered markets or under a bilateral sales contract with a purchaser of the renewable energy located in the ISO -NE control area by properly completing a North American Electric Reliability Corporation tag from the generator in the adjacent control area to either a node or zone in the ISO -NE control area; (2) complies with all ISO -NE rules

B-364

and regulations required to schedule and deliver the renewable energy generating source's energy into the ISO -NE control area; and (3) commits the renewable generating source as a committed capacity resource for the applicable annual period.

(d) During any period in which the generator is delivering renewable energy from the renewable energy generating source into the ISO -NE control area, and notwithstanding compliance with subsection (c), the renewable energy generated by the renewable energy generating source that is eligible for the renewable portfolio standard shall be limited to the lesser of the following: (1) the renewable energy actually generated by the renewable energy generating source; or (2) the renewable energy actually scheduled and delivered into the ISO -NE control area by the generator.

(e) The renewable portfolio standard credit applicable to the eligible renewable energy as determined under subsection (d) shall be reduced by any exports of energy from the ISO -NE control area made by the person seeking renewable portfolio credit for such renewable energy or any affiliate of such person, or any other person under contract with such person to export energy from the ISO -NE control area and deliver such energy directly or indirectly to such person.

(f) The department may adopt regulations and requirements to implement this section.

(g) The department shall assess the feasibility of implementing subsections (c) and (e) and report its findings along with proposed regulations for implementing these subsections in accordance with section 12 of chapter 25A, on or before November 1, 2008 .

(h) Subsections (c) and (e) shall take effect, subject to the provisions of section 12 of chapter 25A, after the report required under subsection (g) has been filed if the department has determined that it is feasible to implement these subsections.

SECTION 106. The department of housing and community development shall make recommendations regarding what supplemental state funds, if any, shall be expended for the federal Low Income Home Energy Assistance Program, under 42 U.S.C. § 8621 et seq., for the purpose of assisting low-income elders, working families and other households with the purchase of heating oil, propane, natural gas, electricity and other primary or secondary heating sources; provided, however, that any recommended expenditures in addition to any federal funding shall be made in accordance with the state plan submitted by the department of housing and community development in accordance with the federal program. The recommendations shall include recommended funding levels and funding sources. The department of housing and community development shall submit its first report on its recommendations to the joint committee on telecommunications, utilities and energy not later than October 1, 2009 , and shall file reports annually not later than October 1.

SECTION 107. The department of energy resources shall conduct a study of the fiscal impact, viability, statutory and regulatory barriers and long-term results of establishing and operating

B-365

municipal-owned electric utilities in the commonwealth. The study shall: (a) address any existing inequities or other barriers preventing the establishment of municipal-owned electric utilities in current statutes or regulations; (b) provide a financial overview of the purchase of an investor owned utility's assets by a municipality; and (c) include a review of the impact on: reliability; investor owned utility operations; municipal taxes; rates for both distribution company customers and municipal customers; lost revenues for investor owned utilities; effect on energy efficiency programs; the impact on capital borrowing; and impact on low-income customers.

There shall be a commission that shall advise the commissioner of energy resources with respect to this study. The commission shall be comprised of the commissioner or a designee who shall serve as chair, and 11 other members as follows: 4 of whom shall be appointed by the executive director of the Massachusetts Municipal Association, 3 of whom shall be from municipalities that are interested in establishing a municipal electric utility; 1 of whom shall be appointed by the attorney general and who shall be from the office of the attorney general; 1 of whom shall be appointed by the commissioner of the department of public utilities and who shall be from the department of public utilities; 1 of whom shall be a municipal finance expert recommended by the Massachusetts Taxpayers Foundation; 1 of whom shall be a representative of the Utility Workers of America; and 2 of whom shall be representatives to be appointed on a voluntary basis by the commissioner, 1 of whom shall be an executive from an investor-owned utility and the other of whom shall be an executive of an existing municipal electric utility. The department of energy resources shall submit the study to the joint committee on telecommunications, utilities and energy not later than January 1, 2009 .

SECTION 108. (a) On or before October 1, 2009 , the department of energy resources shall collaborate with the University of Massachusetts at Boston to establish an educational outreach pilot program designed for communities to further the goals set forth in this section. The pilot program shall include educational programs provided at the University of Massachusetts at Boston , community colleges and community centers. The pilot program shall include short courses designed for presentation at convenient times for communities, including evenings and weekends.

(b) The content of such courses shall include, but not be limited to, the following:

(1) the need for broad public-private collaboration to achieve the acceleration of customer-orientated energy efficiency and conservation programs;

(2) a short-term concentration on retrofitting existing energy control systems to achieve significant energy and financial savings as well recent advancements in this technology;

(3) the basic principles of personal financial accounting to demonstrate that capital investment should achieve the savings identified in clause (2);

(4) the demonstration of the major cost savings of instituting energy efficiency and conservation

programs, including demand side management planning, as compared with the costs of purchasing energy;

(5) existing programs available through public utilities, municipal lighting departments, municipal aggregators and other entities to assist customers with their energy reduction, including any prospective expansion thereof;

(6) the benefits to all energy users resulting from the reduction by individual users of their energy consumption, which reduces the burden on public utilities to procure increasing amounts of energy overall and at moments of peak usage; and

(7) any additional benefits as energy usage becomes more sustainable in the commonwealth.

(c) In preparing and revising the syllabus for such courses, the University of Massachusetts at Boston , shall periodically consult with the department of energy resources, other governmental entities and public utilities to receive feedback about the program. Public utilities may provide instructors for such courses.

(d) The department of energy resources shall issue a report detailing the progress of the pilot program to the clerks of the senate and the house representatives, the joint committee on telecommunications, utilities and energy, and the senate and house committee on ways and means, on or before October 1, 2010 .

SECTION 109. Notwithstanding any general or special law to the contrary, the department of public utilities shall open an investigation and study relative to off-the-record ex-parte communications in any contested, on-the-record proceeding before the department. The department shall report to the general court the results of its investigation and study and its recommendations, if any, together with drafts of legislation necessary to carry its recommendations into effect, by filing the same with the clerks of the senate and the house of representatives who shall forward the same to the chairs of the joint committee on telecommunications, utilities and energy on or before April 1, 2009 .

SECTION 110. Notwithstanding subsection (c) of section 19 of chapter 25 of the General Laws, for 3 years after the expiration of each electric or gas company efficiency plan or agreement in place as of January 1, 2008 , the amount and percentage allocated to the low-income residential subclass for the electric or gas company shall not be reduced to less than the amount provided under law, guidelines and agreements in force as of January 1, 2009 .

SECTION 111. The first plans required under section 21 of chapter 25 of the General Laws shall be prepared and submitted to the energy efficiency advisory council on or before Apri1 30, 2009. The electric and natural gas distribution companies and municipal aggregators shall submit these plans, together with the energy efficiency advisory council’s approval or comments and a statement of any

B-367
unresolved issues, to the department of public utilities on or before October 31, 2009 .

SECTION 112. Not later than March 1, 2009 , the department of environmental protection, in consultation with the department of energy resources, shall adopt regulations for the implementation of section 22 of chapter 21A of the General Laws.

SECTION 113. Clause (i) of paragraph (1) of subsection (c) of section 22 of chapter 21A of the General Laws shall not impact any enforceable multiyear agreements effective during the period from January 1, 2007 , through the implementation of the Regional Greenhouse Gas Initiative, as defined in said section 22 of said chapter 21A.

SECTION 114. Said clause (i) of said paragraph (1) of said subsection (c) of said section 22 of said chapter 21A shall be effective for tax years beginning on or after January 1, 2009 and shall expire on December 31, 2011 .

SECTION 115. Notwithstanding paragraph (2) of subsection (c) of section 22 of chapter 21A of the General Laws, the department of environmental protection may withhold from auction such allowances of vintage years 2009 to 2012, inclusive, as may be necessary to provide a transition to the Regional Greenhouse Gas Initiative from the program established under 310 CMR 7.29.

SECTION 116. (a) It is hereby established that the commonwealth's renewable and alternative energy and energy efficiency goals are as follows:-

(1) meet at least 25 per cent of the commonwealth's electric load, including both capacity and energy, by the year 2020 with demand side resources including: energy efficiency, load management, demand response and generation that is located behind a customer's meter including a combined heat and power system with an annual efficiency of 60 per cent or greater with the goal of 80 per cent annual efficiency for combined heat and power systems by 2020;

(2) meet at least 20 per cent of the commonwealth's electric load by the year 2020 through new, renewable and alternative energy generation;

(3) reduce the use of fossil fuel in buildings by 10 per cent from 2007 levels by the year 2020 through the increased efficiency of both equipment and the building envelope;

(4) develop a plan to reduce total energy consumption in the commonwealth by at least 10 per cent by 2017 through the development and implementation of the green communities program, established by section 10 of chapter 25A of the General Laws, that utilizes renewable energy, demand reduction, conservation and energy efficiency. Not later than September 1 of each year, the secretary of energy and environmental affairs shall establish an annual reduction target for the commonwealth for the following calendar year.

B-368

(b) The secretary of energy and environmental affairs shall prepare, with the assistance of the energy advisory board established under subsection (c), a 5-year plan for meeting the renewable and alternative energy and energy efficiency goals of the commonwealth. The plan shall include strategies to meet each of the goals and shall also address the following topics:

(1) reduction of energy use in state buildings;

(2) reduction of energy use in municipal buildings;

(3) equitable distribution of program benefits to all customers and particularly low income customers to address the affordability and adverse impacts on low-income households of energy costs and demand mitigation strategies, and mitigation of such adverse impacts, such as by compensating adjustments to the low-income rate discount;

(4) the use of investment tax credits and tax policy generally to encourage investment in energy efficiency and renewable and alternative technologies;

(5) increased generation and use of renewable and alternative energy;

(6) the coordination and integration of programs within the commonwealth and with regional efforts carried out by other New England states; and

(7) progress towards improving the efficiency of buildings and mechanical systems on an all-fuels basis including, electric, gas and oil.

(c) The secretary of energy and environmental affairs shall appoint an advisory board to assist in the development and review of the plan. The board shall meet at the call of the secretary. The secretary shall submit the plan to the speaker of the house of representatives, the president of the senate, the senate and house committees on ways and means, and the joint committee on telecommunications, utilities and energy.

(d) The 5-year plan shall designate the agency responsible for implementation of each strategy and shall include timelines, performance standards, specific regulatory or legislative changes, evaluation procedures and additional budget requirements.

SECTION 117. Section 21 of chapter 21A of the General Laws shall take effect on July 1, 2008 .

SECTION 118. Subsections (c), (d) and (e) of section 11F of chapter 25A of the General Laws shall take effect on January 1, 2009 .

SECTION 119. Subsection (a) of section 11F1/2 of chapter 25A of the General Laws shall take effect on January 1, 2009 .

B-369

SECTION 120. Subsection (o) of chapter 143 of the General Laws shall take effect 6 months after the effective date of this act.

SECTION 121. Section 5 shall take effect 1 year after the effective date of this act.

SECTION 122. Section 59 shall take effect on June 30, 2012 .

SECTION 123. Section 53 shall take effect 3 years after the effective date of this act

SECTION 124. Section 80 shall take effect on April 10, 2007.

Approved July 2, 2008.

B-370

Print

Acts 2008

CHAPTER 206 AN ACT RELATIVE TO CLEAN ENERGY BIOFUELS.

Whereas, The deferred operation of this act would tend to defeat its purpose, which is to provide forthwith for the immediate production and use of clean biofuels to reduce oil dependence and greenhouse gas emissions in the commonwealth, therefore it is hereby declared to be an emergency law, necessary for the immediate preservation of the public convenience.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:

SECTION 1. Chapter 64A of the General Laws is hereby amended by striking out section 1, as appearing in the 2006 Official Edition, and inserting in place thereof the following 2 sections:-

Section 1. As used in this chapter, the following words shall, unless the context otherwise requires, have the following meanings:-

“Appellate tax board”, the board established by section 1 of chapter 58A.
“Average price”, the weighted average selling price per gallon of fuel exclusive of federal and state motor fuel taxes imposed thereon sold by licensees, as determined by the commissioner on a consistent basis from information furnished by distributors, unclassified exporters and unclassified importers with their monthly returns and from other statistical data reflecting the average level of such prices at the time such determination is made.
“Cellulosic biofuel”, fuel that may be used in place of petroleum-based fuel derived from cellulose, hemicellulose or lignin derived from renewable biomass.
“Commissioner”, the commissioner of revenue.
“Department”, the department of energy resources within the executive office of energy and environmental affairs.
“Distributor”, shall include: (1) any person qualified to do business in the commonwealth who produces, refines, manufactures or compounds fuel, as herein defined, or any person who operates a port or pipe line terminal within the commonwealth for the receipt of fuel, as herein defined; and (2) any person who elects to qualify as a distributor by importing into the commonwealth or by receiving within the commonwealth fuel, as herein defined, by pipe line, vessel, tank car or tank truck lots, for resale in pipe line, vessel, tank car or tank truck lots; provided, that no person under clause (2) shall qualify as a distributor unless his facilities is regularly used for the receipt and storage of fuel, as herein defined, are such that not less than 25,000 gallons may be stored in the aggregate, at 1 location within the commonwealth; and provided, further, that at least 75 per cent of the fuel imported or received by him is sold to others for resale exclusive of sales to government instrumentalities.

B-371
“Eligible cellulosic biofuel”, cellulosic biofuel that yields at least a 60 per cent reduction in lifecycle greenhouse gas emissions relative to average lifecycle greenhouse gas emissions for petroleum based fuel sold in 2005, as determined by the department in consultation with the department of environmental protection and the executive office of energy and environmental affairs.
“Feedstock”, raw material used to produce a fuel.
“Fuel”, all products commonly or commercially known or sold as gasoline, including casing-head and absorption or natural gasoline, regardless of their classification or uses; and any liquid prepared, for American Society Testing Materials Method D-86, not more than 9 per cent at 176° Fahrenheit, and which have a distillation range of 150° Fahrenheit, or less, or liquefied gases which would not exist as advertised, offered for sale, or sold for use as or commonly and commercially used as a fuel in internal combustion engines, which when subjected to distillation in accordance with the standard method of test for distillation of gasoline, naphtha, kerosene and similar petroleum products (American Society for Testing Materials Designation D-86) show not less than 10 per cent distilled (recovered) below 347° Fahrenheit (175° Centigrade) and not less than 95 per cent distilled (recovered) below 464° Fahrenheit (240° Centigrade); provided, that the term “fuel” shall not include industrial solvents or naphthas which distill, by said American Society liquids at a temperature of 60° Fahrenheit and a pressure of 14.7 pounds per square inch absolute. For the purposes of this chapter, “fuel” shall include products sold or used as fuel for aircraft, except aircraft fuel as defined in section 1 of chapter 64J.
“Lifecycle greenhouse gas emissions”, the aggregate quantity of greenhouse gas emissions, including direct emissions and significant indirect emissions such as significant emissions from and use changes, as determined by the department in consultation with the department of environmental protection and the executive office of energy and environmental affairs, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.
“Low carbon fuel standard”, a requirement that the average lifecycle greenhouse gas emissions attributable to use of energy in an economic sector are equal to or less than a specified numeric level, or a similar standard or system, such as the requirement contained in California Executive Order S-1-07. The level may be stated as units of greenhouse gas emissions per unit of delivered energy, corrected for differences in the efficiency of the energy in the particular end use; for example the difference between efficiency of a gasoline engine and an electric motor in powering a vehicle. The standard may apply to energy used in motor vehicles or to another energy consuming sector.
“Motor vehicle”, shall include any vehicle propelled by any power other than muscular, except boats, tractors used exclusively for agricultural purposes and such vehicles as run only on rails or tracks.
“Purchaser”, shall include, in addition to its usual meaning, a distributor and unclassified importer in the case of a transfer of fuel by a distributor or an unclassified importer into a motor vehicle, or into a receptacle from which fuel is supplied by him to his own or other motor vehicles.
“Renewable biomass”, non-fossil fuel based material, including: planted crops; crop residues; planted trees and tree residues from sustainably managed forests; waste materials including animal waste, animal by-products, organic portions of municipal solid waste, grease trap waste, construction and

demolition debris; and algae, or as otherwise determined by the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs.
“Sale”, shall include, in addition to its usual meaning, the transfer of fuel by a distributor or an unclassified importer into a motor vehicle or into a receptacle from which fuel is supplied by him to his own or other motor vehicles.
“Tax per gallon”, shall be 21 cents per gallon. For aviation fuel, “tax per gallon” shall mean 7½ per cent of the average price, as determined by the commissioner, for each calendar quarter, computed to the nearest tenth of a cent per gallon; provided, however, that such tax shall not be less than 10 cents per gallon.
“To sell”, in all of its moods and tenses, shall refer to a sale as herein defined.
“Unclassified importer”, any person who imports or causes to be imported fuel, as herein defined, for use, distribution or sale in the commonwealth, but who does not qualify as a distributor.
“Unclassified exporter”, any person licensed as a distributor in another state who exports or causes to be exported fuel, as herein defined, for use, distribution or sale outside the commonwealth, but who does not qualify as a distributor.
“Waste feedstock”, previously used or discarded solid, liquid or contained gaseous material with heating value resulting from industrial, commercial or household food service activities that would otherwise be stored, treated, transferred or disposed. Waste feedstock shall include, but not be limited to: waste vegetable oils, waste animal fats, substances derived from wastewater and the treatment of wastewater or grease trap waste. Waste feedstock shall not include petroleum-based waste or waste that otherwise meets the definition of hazardous waste, unless otherwise determined by the department of environmental protection.

Section 1A. Notwithstanding the definition of “tax per gallon” in section 1 and subject to section 2O of chapter 29, for fuel consisting of eligible cellulosic biofuel or of a blend of gasoline and eligible cellulosic biofuel, the tax per gallon shall be reduced in proportion to the percentage of the fuel content consisting of eligible cellulosic biofuel, measured by available energy content, as determined by the department of energy resources, hereinafter referred to as the department.
Manufacturers and wholesale distributors of cellulosic biofuel who seek to have their fuel classified as eligible cellulosic biofuel shall provide documentation satisfactory to the department that such fuel yields at least a 60 per cent reduction in lifecycle greenhouse gas emissions per unit of delivered energy, in comparison to the petroleum-based fuel displaced.

In determining the percentage reduction in lifecycle greenhouse gas emissions relative to petroleum-based fuel achieved by particular supplies of cellulosic biofuel, the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, shall use information and best practices available from other sources, including other states, the federal government, foreign governments, academic research and private and non-profit organizations.

If the department determines through an initial review that a waste feedstock will yield at least a 60 per

cent lifecycle greenhouse gas reduction, is free of hazardous materials and hazardous waste and meets any other conditions established by the department, the department may exempt fuel produced from such a feedstock from a full lifecycle greenhouse gas emissions analysis.

The department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, shall promulgate rules and regulations necessary to carry out the provisions of this section.

SECTION 2. Chapter 94 of the General Laws is hereby amended by inserting after section 249H the following section:—

Section 249H1/2. (1) As used in this section, the following words shall, unless the context clearly requires otherwise, have the following meanings:-

“BQ-9000”, the National Biodiesel Accreditation Program for producers and marketers of biodiesel fuel, operated by the National Biodiesel Accreditation Commission.
“Commissioner”, the commissioner of the department of energy resources.
“Department”, the department of energy resources within the executive office of energy and environmental affairs.
“Eligible petroleum distillate substitute fuel”, petroleum distillate substitute fuel that yields at least a 50 per cent reduction in lifecycle greenhouse gas emissions relative to average lifecycle greenhouse gas emissions for petroleum distillate fuel sold in 2005, as determined by the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs.
“Feedstock”, the raw material used to produce a fuel.
“Lifecycle greenhouse gas emissions”, the aggregate quantity of greenhouse gas emissions, including direct emissions and significant indirect emissions such as significant emissions from land use changes, as determined by the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.
“Low carbon fuel standard”, a legal requirement that the average lifecycle greenhouse gas emissions attributable to use of energy in an economic sector are equal to or below a specified numeric level, or a similar standard or system, such as the requirement contained in California Executive Order S-1-07. The level may be stated as units of greenhouse gas emissions per unit of delivered energy, corrected for differences in the efficiency of the energy in the particular end use; for example the difference between efficiency of a gasoline engine and an electric motor in powering a vehicle. The standard may apply to energy used in motor vehicles or to another energy consuming sector.

B-374
“Petroleum distillate substitute fuel”, fuel that is derived predominantly from renewable biomass; and meets American Society for Testing and Materials specifications for use in home heating applications, or such other quality certification standards as are approved by the department. For industrial and commercial applications, the department may substitute operational performance requirements that it determines are acceptable.
“Renewable biomass”, non-fossil fuel based material, including: planted crops; crop residues; planted trees and tree residues from sustainably managed forests; waste materials including animal waste, animal by-products, organic portions of municipal solid waste, grease trap waste, construction and demolition debris; and algae, or as otherwise determined by the department in consultation with the department of environmental protection and the executive office of energy and environmental affairs.
“Waste feedstock”, previously used or discarded solid, liquid or contained gaseous material with heating value resulting from industrial, commercial or household food service activities that would otherwise be stored, treated, transferred or disposed. Waste feedstock shall include, but not be limited to: waste vegetable oils, waste animal fats, substances derived from wastewater and the treatment of wastewater or grease trap waste. Waste feedstock shall not include petroleum-based waste or waste that otherwise meets the definition of hazardous waste, unless otherwise determined by the department of environmental protection.

(2) Manufacturers and wholesale distributors of petroleum distillate substitute fuel who seek to have their fuel classified as eligible petroleum distillate substitute fuel shall provide documentation satisfactory to the department that such fuel yields at least a 50 per cent reduction in lifecycle greenhouse gas emissions per unit of delivered energy, in comparison to the petroleum distillate fuel displaced.
In determining the percentage lifecycle greenhouse gas reductions achieved by particular fuels, the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, shall use information and best practices available from other sources, including other states, the federal government, foreign governments, academic research and private and non-profit organizations.
If the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, determines through an initial review that a particular waste feedstock will clearly yield at least a 50 per cent lifecycle greenhouse gas reduction, is free of hazardous materials and hazardous waste, and meets any other conditions set by regulations promulgated by the department, the department may exempt fuel produced from such a material from a full lifecycle greenhouse gas emissions analysis.
For supplies that the department determines meet the criteria above for reductions in greenhouse gas emissions, the department shall certify the supplies as eligible petroleum distillate substitute fuel and shall provide documentation or certificates to suppliers of such fuel showing the number of gallons of neat eligible petroleum distillate substitute fuel supplied. The department shall, by regulation, determine which suppliers the documentation shall apply to, and shall create a mechanism for tracking such supplies.

B-375

(3) Except as provided in paragraph (4), the following shall apply to all number 2 petroleum distillate fuel and all other liquid fuel sold as a substitute for number 2 distillate fuel, offered for sale to end-users, retail sellers or to any other entity that will be providing such fuel directly to end-users in the commonwealth for use in residential, commercial or industrial heating applications. Such fuel must contain at least 2 per cent eligible petroleum distillate substitute fuel, measured by available energy content or as otherwise provided by the department, no later than July 1, 2010. Except as provided in subsection (4), all such fuel must contain at least 3 per cent eligible petroleum distillate substitute fuel no later than July 1, 2011, 4 per cent eligible petroleum distillate substitute fuel no later than July 1, 2012, and 5 per cent eligible petroleum distillate substitute fuel no later than July 1, 2013.

The department shall study the feasibility of applying the percentage requirements above to number 4 and number 6 petroleum distillate fuel, including whether blends of eligible petroleum distillate substitute fuel with number 4 or number 6 petroleum distillate fuel will operate correctly in applicable heating equipment. If the department determines that doing so is feasible, it shall extend the percentage requirements above to number 4 and number 6 petroleum distillate fuel.

The department may delay these implementation dates for the period of time which it determines, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, that providing sufficient supplies of the required eligible petroleum distillate substitute fuel to end-use consumers is not feasible due to lack of supply, lack of blending facilities or unreasonable cost. If the department delays implementation as provided in the preceding sentence, the commissioner shall file a report within 30 days of such decision with the clerks of the house of representatives and senate who shall forward the same to the house and senate committees on ways and means, the joint committee on telecommunications, utilities and energy, the joint committee on environment, natural resources and agriculture and the joint committee on transportation explaining the reasons for any such decision to delay implementation.

If a low carbon fuel standard or a similar standard or system, that will achieve equal or greater reductions in greenhouse gas emissions to the minimum content requirement for eligible petroleum distillate substitute fuel specified by this section, is adopted by the commonwealth, or a standard applying to the commonwealth is adopted by the federal government; then at least 60 days prior to the effective date of the standard the department of environmental protection shall submit a statement to the general court that the standard will become effective on the particular date, and the department of environmental protection’s determination that the standard will achieve the specified reduction in emissions. If the general court takes no action, the minimum content requirement specified by this section shall expire on the date that the regulations implementing the standard or system becomes effective, or at such other date specified by the department, but in any case within 1 year of implementation of the regulations. If the department chooses an expiration date other than the effective date of the regulations it shall submit a statement to the general court explaining its reasons for doing so prior to said effective date.

B-376

(4) The department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, shall study the feasibility, benefits and costs, including benefits and costs to consumers, producers and the state government, of making the percentage mandates in subsection (3) apply on a statewide average basis rather than for every gallon of petroleum distillate fuel sold for heating purposes. If the department determines that such a system is feasible and that its benefits substantially exceed its costs, the department shall have the authority to implement such a system. The department shall determine on which entities the percentage requirements shall be applied. If the department implements such a system, the department shall promulgate regulations allowing and tracking sales of certificates or other documentation from the department that show use of eligible petroleum distillate substitute fuel in the commonwealth. Entities may meet their percentage requirements for use of eligible petroleum distillate substitute fuel by purchasing certificates or other documentation, and such certificates may be re-sold.

(5) Manufacturers and wholesale distributors of eligible petroleum distillate substitute fuel, and of fuel blended from petroleum distillate and eligible petroleum distillate substitute, doing business in the commonwealth shall furnish samples of such products to the department, shall permit the entry and inspection by the department or the department of environmental protection of the premises of such manufacturers or distributors, and the inspection and sampling of fuel stored thereon.

(6) Manufacturers of eligible petroleum distillate substitute fuel that is sold in the commonwealth shall meet quality assurance criteria or accreditation requirements determined by the department, in consultation with the department of environmental protection. Manufacturers shall submit documentation of quality assurance or accreditation to the department by November 1, 2009, or at least 3 months prior to the date on which the department certifies their fuel as eligible petroleum distillate substitute fuel, and shall submit documentation to the department showing that their accreditation remains current every 2 years thereafter.

(7) The department shall evaluate the feasibility and desirability of requiring BQ-9000 or other comparable accreditation requirement for producers and wholesale distributors of petroleum distillate substitute fuel and petroleum distillate fuel blended with petroleum distillate substitute fuel operating in the commonwealth. If the department concludes that such accreditation is feasible and desirable in order to protect consumers and the environment, the department shall promulgate regulations to implement an accreditation requirement.

(8) The department shall promulgate regulations to implement the provisions of this section.

(9) No person shall sell or offer to sell petroleum distillate heating fuel in the commonwealth, including eligible petroleum distillate substitute fuel that does not conform to the provisions of this section.

(10) Notwithstanding section 249H, failure to comply with subsection (9) of this section shall constitute

B-377
an unfair or deceptive act under chapter 93A, and may be enforced as provided therein.

SECTION 3. Said chapter 94 is hereby further amended by inserting after section 295G the following section:—

Section 295G½. (1) As used in this section, the following words shall have the following meanings:-

“BQ-9000”, the National Biodiesel Accreditation Program for producers and marketers of biodiesel fuel, operated by the National Biodiesel Accreditation Commission.
“Commissioner”, the commissioner of the department of energy resources.
“Department”, the department of energy resources within the executive office of energy and environmental affairs.
“Diesel substitute fuel”, fuel that is derived predominantly from renewable biomass; that meets American Society for Testing and Materials specifications for use in diesel engines, or that meets such other quality certification standards as are approved by the department for the application involved. For diesel substitute fuel used in on-road motor vehicles, the fuel shall meet the registration requirements for fuels and fuel additives established by the United States Environmental Protection Agency under section 211C of the Clean Air Act, 42 USC section 7545.
“Eligible diesel substitute fuel”, diesel substitute fuel that yields at least a 50 per cent reduction in lifecycle greenhouse gas emissions relative to average emissions for petroleum-based diesel fuel sold in 2005, as determined by the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs.
“Feedstock”, the raw material used to produce a fuel.
“Lifecycle greenhouse gas emission”, the aggregate quantity of greenhouse gas emissions, including direct emissions and significant indirect emissions such as significant emissions from land use changes, as determined by the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.
“Low carbon fuel standard”, a legal requirement that the average lifecycle greenhouse gas emissions attributable to use of energy in an economic sector are equal to or below a specified numeric level, or a similar standard or system, such as the requirement contained in California Executive Order S-1-07. The level may be stated as units of greenhouse gas emissions per unit of delivered energy, corrected for differences in the efficiency of the energy in the particular end use; for example the difference between efficiency of a gasoline engine and an electric motor in powering a vehicle. The standard may apply to energy used in motor vehicles or to another energy consuming sector.
“Renewable biomass”, non-fossil fuel based material, including: planted crops; crop residues; planted trees and tree residues from sustainably managed forests; waste materials including animal waste, animal by-products, organic portions of municipal solid waste, grease trap waste, construction and

demolition debris; and algae, or as otherwise determined by the department in consultation with the department of environmental protection and the executive office of energy and environmental affairs. “Waste feedstock”, previously used or discarded solid, liquid or contained gaseous material with heating value resulting from industrial, commercial or household food service activities that would otherwise be stored, treated, transferred or disposed. Waste feedstock shall include, but not be limited to: waste vegetable oils, waste animal fats, substances derived from wastewater and the treatment of wastewater and grease trap waste. Waste feedstocks shall not include petroleum-based waste or waste that otherwise meets the definition of hazardous waste, unless otherwise determined by the department of environmental protection.

(2) Manufacturers and wholesale distributors of diesel substitute fuel doing business in the commonwealth who wish to have their fuel classified as eligible diesel substitute fuel shall provide documentation satisfactory to the department that such fuel yields at least a 50 per cent reduction in lifecycle greenhouse gas emissions per unit of delivered energy, in comparison to the petroleum-based diesel fuel displaced.

In determining the percentage lifecycle greenhouse gas reductions achieved by particular fuels, the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, shall use information and best practices available from other sources, including other states, the federal Environmental Protection Agency, foreign governments, academic research and private and non-profit organizations.
If the department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, determines through an initial review that a particular waste feedstock will clearly yield at least a 50 per cent lifecycle greenhouse gas reduction, is free of hazardous materials and hazardous waste, and meets any other conditions set by regulations promulgated by the department, the department may exempt fuel produced from such a material from a full lifecycle greenhouse gas emissions analysis.

For supplies that the department determines meet the criteria above for reductions in greenhouse gas emissions, the department shall, by regulation, certify the supplies as eligible diesel substitute fuel and shall provide documentation or certificates to suppliers of such fuel showing the number of gallons of neat eligible diesel substitute fuel supplied. The department shall, by regulation, determine which suppliers the documentation shall apply to, and create a mechanism for tracking such supplies.

(3) Except as provided in subsection (4), the following shall apply to all diesel motor vehicle fuel and all other liquid fuel used in motor vehicle diesel engines, offered for sale to end-users, retail sellers or to any other entity that will be providing such fuel directly to end-users in the commonwealth for use in transportation. All such fuel must contain at least 2 per cent eligible diesel substitute fuel, measured by available energy content or in such other manner as determined by the department no later than July 1, 2010. Except as provided in subsection (4), all such fuel must contain at least 3 per cent eligible diesel substitute fuel no later than July 1, 2011, 4 per cent eligible diesel substitute fuel no later than

B-379

July 1, 2012, and 5 per cent eligible diesel substitute fuel no later than July 1, 2013.

The department may delay these implementation dates for the period of time which it determines, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, that providing sufficient supplies of the required eligible diesel substitute fuel to end-use consumers is not feasible due to lack of supply, lack of blending facilities or unreasonable cost. If the department delays implementation as provided in the preceding sentence, the commissioner shall file a report within 30 days of such decision with the clerks of the house of representatives and senate who shall forward the same to the house and senate committees on ways and means, the joint committee on telecommunications, utilities and energy, the joint committee on environment, natural resources and agriculture and the joint committee on transportation explaining the reasons for any such decision to delay implementation.

If a low carbon fuel standard or a similar standard or system, that will achieve equal or greater reductions in greenhouse gas emissions to the minimum content requirement specified by this section is adopted by the commonwealth, or a standard applying to the commonwealth is adopted by the federal government, then at least 60 days prior to the effective date of the standard, the department shall submit a statement to the general court that the standard shall become effective on the particular date, and the department of environmental protection's determination that the standard will achieve the specified reduction in emissions. If the general court takes no action, the minimum content requirement specified by this section shall expire on the date that the regulations implementing the standard or system becomes effective, or at such other date specified by the department, but in any case within 1 year of implementation of the regulations. If the department chooses an expiration date other than the effective date of the regulations it shall submit a statement to the general court explaining its reasons for doing so prior to said effective date.

(4) The department, in consultation with the department of environmental protection and the executive office of energy and environmental affairs, shall study the feasibility, benefits and costs, including benefits and costs to consumers, producers and the commonwealth, of making the percentage mandates in subsection (3) apply on a statewide average basis rather than for every gallon of diesel motor fuel sold. If the department implements such a system, the department shall promulgate regulations allowing and tracking sales of certificates or other documentation from the department that show use of eligible diesel substitute fuel in the commonwealth. Entities may meet their percentage requirements for use of eligible diesel substitute fuel by purchasing certificates or other documentation, and such certificates may be re-sold.

(5) Manufacturers and wholesale distributors of eligible diesel substitute fuel, and of fuel blended from petroleum diesel and eligible diesel substitute, doing business in the commonwealth shall furnish samples of such products to the department, shall permit the entry and inspection by the division and department of the premises of such manufacturers or distributors and the inspection and sampling of

B-380

fuel stored thereon.

(6) Manufacturers of eligible diesel substitute fuel that is sold in the commonwealth shall meet quality assurance criteria or accreditation requirements determined by the department, in consultation with the department of environmental protection. Manufacturers shall submit documentation of quality assurance or accreditation to the department on or before November 1, 2009, or at least 3 months prior to the date on which the department certifies their fuel as eligible diesel substitute fuel, and must submit documentation to the department showing that their accreditation remains current every 2 years thereafter.

(7) The department shall evaluate the feasibility and desirability of requiring BQ-9000 or other comparable accreditation requirement for producers and wholesale distributors of diesel substitute fuel and petroleum-based motor fuel blended with diesel substitute fuel operating in the commonwealth. If the department concludes that such accreditation is feasible and desirable in order to protect consumers and the environment, the department shall promulgate regulations to implement an accreditation requirement.

(8) The department shall promulgate regulations to implement the provisions of this section.

(9) No person shall sell or offer to sell heating fuel, including eligible diesel substitute fuel, that does not conform to this section.

(10) Notwithstanding section 249H, failure to comply with subsection (9) shall constitute an unfair or deceptive act under the provisions of chapter 93A, and may be enforced as provided therein.

SECTION 4. The division of energy resources, in consultation with the department of revenue, shall promulgate regulations concerning the timing and form of documentation that will enable the department to determine the appropriate tax revenue to be collected pursuant to this act.

SECTION 5. There is hereby established a special commission to study the feasibility and effectiveness of various forms of incentives to promote the development and use of advanced biofuels in the commonwealth including, but not limited to: production credits, the production and harvesting of woody biomass or woody residue, feedstock incentives and direct consumer credits for the use of advanced biofuels in various applications. The commission shall be comprised of 11 members: 3 of whom shall be appointed by the speaker of the house of representatives, 1 of whom shall be the house chair of the joint committee on telecommunication, utilities and energy, who shall serve as co-chair; 1 of whom shall be appointed by the house minority leader; 3 of whom shall be appointed by the senate president, 1 of whom shall be the senate chair of the joint committee on telecommunication, utilities and energy, who shall serve as co-chair; 1 of whom shall be appointed by the senate minority leader; and 3 of whom shall be appointed by the governor, 1 of whom shall be the secretary of the executive office of energy and environmental affairs, or his designee, and 1 of whom shall be

employed by a company that works in the field of advanced biofuels. In conducting its investigation and study, the commission shall consider biofuel incentive programs in other states and the commonwealth's relative competitiveness in the field.

The commission shall report to the general court the results of its investigation and study and its recommendations, if any, together with drafts of legislation necessary to carry its recommendations into effect, by filing the same with the clerks of the house of representatives and the senate, who shall forward the same to the joint committee on telecommunications, utilities and energy and the house and senate committees on ways and means on or before March 31, 2009 .

SECTION 6. The governor and the secretary of energy and environmental affairs shall develop and enter into, to the extent possible, an agreement among those states participating in the Regional Greenhouse Gas Initiative, for the purpose of implementing a low carbon fuel standard hereinafter referred to as LCFS, for transportation fuels; provided, however, that when possible:

(1) the LCFS shall be measured on a full fuels cycle basis;
(2) the LCFS may be met through market-based methods by which providers exceeding the performance required by an LCFS shall receive credits that may be applied to future obligations or traded to providers not meeting the LCFS;
(3) the agreement shall establish a declining standard for greenhouse gas emissions measured in CO2-equivalent grams per unit of fuel energy sold, sufficient to achieve a 10 per cent reduction in the carbon content of all passenger vehicle fuels sold in participating states; and
(4) the commonwealth shall, with the other states participating in the agreement, examine the regulations and implementation of a low carbon fuel standard in California and other states and shall consider ways to coordinate and issue public findings on both such matters, and shall, if applicable, use in the agreement the life-cycle analysis methods employed by the California Air Resources Board to determine the carbon intensity of fuel.

SECTION 7. There shall be a special commission to investigate and develop a strategy to increase the use of advanced biofuels as alternatives to conventional carbon-based fuels by the commonwealth, its agencies and political subdivisions and regional transit authorities.

The commission shall consist of the secretary of administration and finance or his designee, the secretary of energy and environmental affairs, who shall serve as the chair, the commissioner of energy resources, commissioner of the department of public utilities, the commissioner of revenue or his designee, the general manager of the Massachusetts Bay Transportation Authority or his designee, and 6 members to be appointed by the governor, 2 of whom shall represent the Massachusetts Municipal Association, 2 of whom shall represent regional transit authorities, 1 of whom shall represent environmental organizations in the commonwealth, and 1 of whom shall represent suppliers of motor fuels in the commonwealth.

B-382

The commission shall develop strategies to increase the use of advanced biofuels by the commonwealth, its agencies and political subdivisions and regional transit authorities and methods to advance those strategies. Methods to be considered shall include, but not be limited to: financing mechanisms including grants, loans and other incentive programs for group procurement of advanced biofuels, vehicles using advanced biofuels and distribution infrastructure and technical assistance.

The commission shall file a report detailing its strategies and methods and its recommendations, if any, and cost estimates together with drafts of legislation necessary to carry those recommendations into effect by filing the same with the clerks of the senate and house of representatives on or before April 15, 2009.

SECTION 8. Section 1 shall be effective for tax years beginning January 1, 2009 and ending December 31, 2017.

Approved July 28, 2008

B-383

Print

Acts 2008

CHAPTER 298 AN ACT ESTABLISHING THE GLOBAL WARMING SOLUTIONS ACT.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:

SECTION 1. Section 19 of chapter 6A of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by striking out subsection (f) and inserting in place thereof the following 2 subsections:-

(f) The secretary shall collaborate with other state agencies to reduce greenhouse gas emissions to achieve the greenhouse gas emission limits established in chapter 21N.
(g) Nothing in this chapter shall be construed to confer any powers or impose any duties upon the secretary with respect to the foregoing agencies and authorities except as expressly provided by law.

SECTION 2. Section 1 of chapter 16 of the General Laws, as so appearing, is hereby amended by striking out subsection (d) and inserting in place thereof the following 2 subsections:-

(d) The commissioner shall collaborate with other state agencies to reduce greenhouse gas emissions to the limits established in chapter 21N.
(e) The commissioner may promulgate rules and regulations to effectuate the purposes of this chapter.

SECTION 3. Section 2 of chapter 21A of the General Laws, as so appearing, is hereby amended by adding the following clause:-
(30) consistent with chapter 21N, oversee state agency efforts to address and diminish the impacts of climate change by coordinating state agency actions to achieve the greenhouse gas emissions limits established in chapter 21N.

SECTION 4. Section 8 of said chapter 21A, as so appearing, is hereby amended by inserting after the second paragraph the following paragraph:-
The department of environmental protection shall assist in the implementation of chapter 21N.

SECTION 5. Section 16 of said chapter 21A, as so appearing, is hereby amended by adding the following paragraph:-
Any person who fails to comply with or otherwise violates chapter 21N shall be liable for a civil administrative penalty not to exceed $25,000 for each day the violation continues.

B-384

SECTION 6. The General Laws are hereby amended by inserting after chapter 21M the following chapter:-

Chapter 21N.
CLIMATE PROTECTION AND GREEN ECONOMY ACT.

Section 1. As used in this chapter the following words shall have the following meanings unless the context clearly requires otherwise:-

“Allowance”, an authorization to emit, during a specified year, up to 1 ton of carbon dioxide equivalent.

“Alternative compliance mechanism”, an action undertaken by a greenhouse gas emission source that achieves the equivalent reduction of greenhouse gas emissions over the same time period as a direct emissions reduction, that is approved by the department, and that is real, permanent, quantifiable, verifiable and enforceable.

“Carbon dioxide equivalent”, the amount of carbon dioxide by weight that would produce the same global warming impact as a given weight of another greenhouse gas, based on the best available science, including from the Intergovernmental Panel on Climate Change.

“Department”, the department of environmental protection.

“Direct emissions”, emissions from sources that are owned or operated, in whole or in part, by an entity or facility including, but not limited to, emissions from factory stacks, manufacturing processes and vents, and company owned or company-leased motor vehicles.

“Direct emissions reduction”, a greenhouse gas emission reduction action made by a greenhouse gas emissions source at that source.

“Emission”, emission of a greenhouse gas into the air.

“Emissions reduction measures”, programs, measures, standards, and alternative compliance mechanisms authorized pursuant to this chapter, applicable to sources or categories of sources that are designed to reduce emissions of greenhouse gases.

“Entity”, a person that owns or operates, in whole or in part, a source of greenhouse gas emissions from a generator of electricity or a commercial or industrial site including, but not limited to, a transportation fleet.

“Executive office”, the executive office of energy and environmental affairs.

“Facility”, a building, structure or installation located on contiguous or adjacent properties of an entity.

“Greenhouse gas”, any chemical or physical substance that is emitted into the air and that the department may reasonably anticipate will cause or contribute to climate change including, but not limited to, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

“Greenhouse gas emissions limit”, an authorization, during a specified year, to emit up to a level of greenhouse gases specified by the secretary, expressed in tons of carbon dioxide equivalents.

“Greenhouse gas emissions source”, a source, or category of sources, of greenhouse gas emissions with emissions that are at a level of significance, as determined by the secretary, that its participation in the program established under this chapter will enable the secretary to effectively reduce greenhouse gas emissions and monitor compliance with the statewide greenhouse gas emissions

B-385

limit.

“Indirect emissions”, emissions associated with the consumption of purchased electricity, steam and heating or cooling by an entity or facility.

“Leakage”, the offset of a reduction in emissions of greenhouse gases within the commonwealth by an increase in emissions of greenhouse gases outside the commonwealth.

“Market-based compliance mechanism”, (i) a system of market-based declining annual aggregate emissions limitations for sources or categories of sources that emit greenhouse gases; or (ii) greenhouse gas emissions exchanges, banking, credits and other transactions governed by rules and protocols established by the secretary or the regional greenhouse gas initiative, that result in the same greenhouse gas emissions reduction, over the same time period, as direct compliance with a greenhouse gas emissions limit or emission reduction measure adopted by the executive office pursuant to this chapter.

“Person”, an agency or political subdivision of the commonwealth, a state, public or private corporation or authority or an individual, trust firm, joint stock company, partnership, association or other entity or group thereof or an officer, employee or agent thereof.

“Secretary”, the secretary of energy and environmental affairs.

“Statewide greenhouse gas emissions”, the total annual emissions of greenhouse gases in the commonwealth, including all emissions of greenhouse gases from the generation of electricity delivered to and consumed in the commonwealth, accounting for transmission and distribution line losses, whether the electricity is generated in the commonwealth or imported; provided, however, that statewide greenhouse gas emissions shall be expressed in tons of carbon dioxide equivalents.

“Statewide greenhouse gas emissions limit”, the maximum allowable level of statewide greenhouse gas emissions in a given year, as determined by the secretary.

Section 2. (a) The department shall monitor and regulate emissions of greenhouse gases with the goal of reducing those emissions. The department shall adopt regulations to require the reporting and verification of statewide greenhouse gas emissions and to monitor and enforce compliance with this chapter. The regulations shall: (1) establish a regional greenhouse gas registry and reporting system for greenhouse gas emission sources; provided, however, that in establishing the greenhouse gas registry and reporting system, the department may collaborate with other states or a regional consortium; (2) annually require the owner or operator of any facility that is required to report air emissions data to the department pursuant to Title V of the federal Clean Air Act and that has stationary emissions sources that emit greenhouse gases to report annually to the regional registry direct stack emissions of greenhouse gases from such sources; (3) require the owner or operator of a facility that has stationary emissions sources that emit greenhouse gases in excess of 5,000 tons of greenhouse gases per year in carbon dioxide equivalents to report annually to the regional registry direct emissions of greenhouse gases from such sources; provided, however, that the department shall develop a simplified estimation form to assist facilities in determining who shall report emissions and shall consider, on an annual basis, requiring the expansion of reporting to the regional greenhouse gas registry; (4) provide for the voluntary reporting of emissions of greenhouse gases to the regional greenhouse gas registry by entities and facilities that are not required to submit

B-386
information pursuant to clauses (2) and (3); provided, however, that the greenhouse gas emissions reported shall be of a type and format that the regional greenhouse gas registry can accommodate; (5) require reporting of greenhouse gas emissions from generation sources producing all electricity consumed, including transmission and distribution line losses from electricity generated within the commonwealth or imported from outside the commonwealth; provided, however, that this requirement shall apply to all retail sellers of electricity, including electric utilities, municipal electric departments and municipal light boards as defined in section 1 of chapter 164A; (6) ensure rigorous and consistent accounting of emissions and provide reporting tools and formats to ensure collection of necessary data; and (7) ensure that greenhouse gas emissions sources maintain comprehensive records of all reported greenhouse gas emissions.
(b) The department shall: (1) consult with the secretary on periodic review and updates of emission reporting requirements, as necessary; and (2) review existing and proposed state, federal and international greenhouse gas emissions reporting programs and make reasonable efforts to promote consistency among the programs established pursuant to this chapter and other programs and to streamline reporting requirements on greenhouse gas emissions sources.
(c) The department shall triennially publish a state greenhouse gas emissions inventory that includes comprehensive estimates of the quantity of greenhouse gas emissions in the commonwealth for the last 3 years in which data is available.

Section 3. (a) The department shall, pursuant to chapter 30A, determine the statewide greenhouse gas emissions level in calendar year 1990 and reasonably project what the emissions level will be in calendar year 2020 if no measures are imposed to lower emissions other than those formally adopted and implemented as of January 1, 2009. This projection shall hereafter be referred to as the projected 2020 business as usual level.
(b) The secretary shall, in consultation with the department and the department of energy resources, adopt the following statewide greenhouse gas emissions limits: (1) a 2020 statewide emissions limit and a plan to achieve that limit pursuant to section 4; (2) an interim 2030 emissions limit accompanied by plans to achieve this limit in accordance with said section 4; provided, however, that the 2030 interim emissions limits shall maximize the ability of the commonwealth to meet the 2050 emissions limit; (3) an interim 2040 emissions limit accompanied by plans to achieve this limit in accordance with said section 4; provided, however, that the 2040 interim emissions limit shall maximize the ability of the commonwealth to meet the 2050 emissions limit; and (4) a 2050 statewide emissions limit that is at least 80 per cent below the 1990 level.
(c) Emissions levels and limits associated with the electric sector shall be established by the executive office and the department, in consultation with the department of energy resources, based on consumption and purchases of electricity from the regional electric grid, taking into account the regional greenhouse gas initiative and the renewable portfolio standard.
(d) The department shall promulgate regulations establishing a desired level of declining annual aggregate emission limits for sources or categories of sources that emit greenhouse gas emissions.

Section 4. (a) The secretary shall adopt the 2020 statewide greenhouse gas emissions limit pursuant

B-387
to subsection (b) of section 3 which shall be between 10 per cent and 25 per cent below the 1990 emissions level and a plan for achieving said reduction. The secretary shall consult with all state agencies and regional authorities with jurisdiction over sources of greenhouse gases on all elements of the emissions limit and plan that pertain to energy-related matters including, but not limited to, electrical generation, load based-standards or requirements, the provision of reliable and affordable electrical service and statewide fuel supplies, to ensure the greenhouse gas emissions reduction activities to be adopted and implemented by the secretary are complementary, non-duplicative and can be implemented in an efficient and cost-effective manner. The 2020 statewide emissions limit and implementation plan shall comply with this section.
(b) The secretary shall analyze the feasibility of measures to comply with the emissions limit established in subsection (a). Such measures shall include, but not be limited to, the electric generating facility aggregate limit established pursuant to section 12, direct emissions reduction measures from other sectors of the economy, alternative compliance mechanisms, market-based compliance mechanisms and potential monetary and nonmonetary incentives for sources and categories of sources that the secretary finds are necessary or desirable to facilitate the achievement of reductions of greenhouse gas emissions limits.
(c) The secretary shall consider all relevant information pertaining to greenhouse gas emissions reduction goals and programs in other states and nations.
(d) The secretary shall evaluate the total potential costs and economic and noneconomic benefits of various reduction measures to the economy, environment and public health, using the best available economic models, emissions estimation techniques and other scientific methods.
(e) The secretary shall take into account the relative contribution of each source or source category to statewide greenhouse gas emissions and shall recommend a de minimis threshold of greenhouse gas emissions below which emissions reduction requirements shall not apply.
(f) The secretary shall identify opportunities for emissions reduction measures from all verifiable and enforceable voluntary actions.
(g) The secretary shall conduct public hearings on the proposed 2020 emission limit and implementing plan. The secretary shall conduct a portion of these workshops in regions that have the most significant exposure to air pollutants, including, but not limited to, communities with minority populations, communities with low-income populations, or both.
(h) The secretary shall update its plan for achieving the maximum technologically feasible reductions of greenhouse gas emissions at least once every 5 years, including the plans to implement the 2030, 2040 and 2050 statewide emission limits.

Section 5. The secretary shall monitor the implementation of regulations relative to climate change and shall, every 5 years, publish a report which shall include recommendations regarding such implementation. The report shall include, without limitation: (i) whether regulations or other measures undertaken, including distribution of emissions allowances, are equitable and minimize costs and maximize the total benefits to the commonwealth and encourage early action to reduce greenhouse gas emissions; (ii) whether activities undertaken to comply with state regulations and efforts

B-388

disproportionately impact low-income communities; (iii) whether entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of this chapter receive appropriate credit for early voluntary reductions; (iv) whether activities undertaken pursuant to the regulations complement, and do not interfere with, efforts to achieve and maintain federal and state ambient air quality standards and reduce toxic air contaminant emissions; (v) consider overall societal benefits, including reductions in other air pollutants, diversification of energy sources and other benefits to the economy, environment and public health; (vi) whether state actions minimize the administrative burden of implementing and complying with these regulations; (vii) whether state actions minimize leakage; (viii) consider the significance of the contribution of each source or category of sources to statewide emissions of greenhouse gases; (ix) whether greenhouse gas emissions reductions achieved are real, permanent, quantifiable, verifiable and enforceable; and (x) recommendations for future policy action. The report shall be filed with the clerk of the house of representatives, the clerk of the senate, the chairs of the house and senate committees on ways and means, the chairs of the joint committee of telecommunications, utilities and energy and the chairs of the joint committee on the environment, natural resources and agriculture.

Section 6. In implementing its plan for statewide greenhouse gas emissions limits, the commonwealth and its agencies shall promulgate regulations that reduce energy use, increase efficiency and encourage renewable sources of energy in the sectors of energy generation, buildings and transportation.

Section 7. (a) The secretary, in consultation with the executive office of administration and finance, may consider the use of market-based compliance mechanisms to address climate change concerns; provided, however, that prior to the use of any market-based compliance mechanism, to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the secretary shall: (1) consider the potential for direct, indirect and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution; (2) design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants, with particular attention paid to emissions of nitrous oxide, sulfur dioxide and mercury; and (3) maximize additional environmental and economic benefits for the commonwealth, as appropriate.

(b) The secretary may adopt regulations governing how market-based compliance mechanisms may be used by regulated entities subject to greenhouse gas emissions limits and mandatory emissions reporting requirements to achieve compliance with their greenhouse gas emissions limits.

(c) The executive office and the department may work with the participating regional greenhouse gas initiative states and other interested states and Canadian Provinces to develop a plan to expand market-based compliance mechanisms such as the regional greenhouse gas initiative to other sources and sectors necessary or desirable to facilitate the achievement of the greenhouse gas emissions limits.

(d) The executive office shall monitor compliance with and enforce any rule, regulation, order, emissions limitation, emissions reduction measure or market-based compliance mechanism adopted

B-389

by the executive office or department pursuant to this chapter. The department may impose a civil administrative penalty pursuant to section 16 of chapter 21A for a violation of any rule, regulation, order, emissions limitation, emissions reduction measure or other measure adopted by the executive office pursuant to this chapter.

Section 8. The secretary shall convene an advisory committee to advise the executive office in overseeing the greenhouse emissions reduction measures. The advisory committee shall consist of representatives from the following sectors: commercial, industrial and manufacturing; transportation; low-income consumers; energy generation and distribution; environmental protection; energy efficiency and renewable energy; local government; and academic institutions.

Section 9. Nothing in this chapter shall affect the authority of the public utility commission or the obligation of an electrical utility to provide customers with safe and reliable electric service. Nothing in this chapter shall preclude, prohibit or restrict the construction of a new facility or the expansion of an existing facility subject to regulation under this chapter, if all applicable requirements are met and the facility is in compliance with regulations adopted pursuant to this chapter.

SECTION 7. Section 61 of chapter 30 of the General Laws is hereby amended by inserting after the first paragraph, as appearing in the 2006 Official Edition, the following paragraph:-

In considering and issuing permits, licenses and other administrative approvals and decisions, the respective agency, department, board, commission or authority shall also consider reasonably foreseeable climate change impacts, including additional greenhouse gas emissions, and effects, such as predicted sea level rise.

SECTION 8. Nothing in this act shall restrict the secretary of energy and environmental affairs from adopting greenhouse gas emissions limits or emissions reduction measures prior to January 1, 2011, that are consistent with general or special laws or rules or regulations, imposing those limits prior to January 1, 2012, or providing early reduction credit, where appropriate, nor shall this act prevent the imposition of more stringent limits on emissions.

SECTION 9. Notwithstanding any general or special law to the contrary, the secretary shall convene an advisory committee to analyze strategies for adapting to the predicted impacts of climate change in the commonwealth. The advisory committee shall be chaired by the secretary, or his designee, and comprised of representatives with expertise in the following areas: transportation and built infrastructure; commercial, industrial and manufacturing activities; low income consumers; energy generation and distribution; land conservation; water supply and quality; recreation; ecosystems dynamics; coastal zone and oceans; rivers and wetlands; and local government.

The committee shall file a report of its findings and recommendations regarding strategies for adapting to climate change not later than December 31, 2009.

B-390

SECTION 10. Notwithstanding any general or special law to the contrary, the executive office of energy and environmental affairs shall promulgate regulations pursuant to section 2 of chapter 21N of the General Laws not later than January 1, 2009.

SECTION 11. Clauses (2) and (3) of the third sentence of subsection (a) of said section 2 of said chapter 21N shall take effect not later than April 15, 2009.

SECTION 12. Clauses (4) and (5) of said third sentence of said subsection (a) of said section 2 of said chapter 21N shall be implemented not later than July 1, 2009.

SECTION 13. The first inventory required pursuant to subsection (c) of said section 2 of said chapter 21N shall be published not later than December 31, 2010.

SECTION 14. Subsection (a) of section 3 of said chapter 21N shall be implemented not later than July 1, 2009.

SECTION 15. Clause (1) of subsection (b) of said section 3 of said chapter 21N shall be implemented not later than January 1, 2011.

SECTION 16. The department of environmental protection shall promulgate regulations pursuant to subsection (d) of said section 3 of said chapter 21N not later than January 1, 2012, which regulations shall take effect on January 1, 2013, and shall expire on December 31, 2020.

SECTION 17. The 2020 statewide greenhouse gas initiative required to be adopted pursuant to subsection (a) of section 4 of said chapter 21N shall be adopted not later than January 1, 2011.

SECTION 18. Notwithstanding any general or special law to the contrary, the executive office of energy and environmental affairs shall publish the report required pursuant to section 5 of said chapter 21N not later than January 1, 2014.

Approved August 7, 2008

B-391

Print

Acts 2008

CHAPTER 307 AN ACT RELATIVE TO GREEN JOBS IN THE COMMONWEALTH.

Whereas, The deferred operation of this act would tend to defeat its purpose, which is to promote forthwith job creation and clean energy technology, therefore it is hereby declared an emergency law, necessary for the immediate preservation of the public convenience.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:

SECTION 1. Chapter 10 of the General laws is hereby amended by striking out section 35FF, inserted by section 10 of chapter 140 of the acts of 2007, and inserting in place thereof the following section:-

Section 35FF. (a) There is hereby established and placed within the Massachusetts clean energy technology center established in section 2 of chapter 23J, hereinafter referred to as the center, a fund to be known as the Massachusetts Alternative and Clean Energy Investment Trust Fund, hereinafter referred to as the fund, to be held by the center separate and apart from its other funds, to finance the activities of the center. The fund shall be credited any appropriations, bond proceeds or other monies authorized by the general court and specifically designated to be credited thereto, such additional funds as are subject to the direction and control of the center, any pension funds, federal grants or loans, royalties, equity ownership in public or private companies or private investment capital which may properly be applied in furtherance of the objectives of the fund, any proceeds from the sale of qualified investments secured or held by the fund, any fees and charges imposed relative to the making of qualified investments, as the same shall be defined by the center, secured or held by the fund and any other monies which may be available to the center for the purposes of the fund from any other source or sources. Any revenues, deposits, receipts or funds received through the receipt of royalties, dividends, equity ownership in public or private companies or the sale of equity instruments, inclusive, shall be deposited in the fund and shall be available expressly to the center without further appropriation.

(b) The center shall, in consultation with the advisory committee established in subsection (d) and the secretary of administration and finance, invest and reinvest the fund and the income thereof only as follows: (1) in the making of qualified investments approved by the board established in subsection (b) of section 2 of chapter 23J, pursuant to rules approved by said board; (2) in defraying the ordinary and necessary expenses of administration and operation associated with the center; provided, however, that said administrative and operational expenses shall not exceed 15 per cent of the total assets of the fund in any 1 fiscal year; (3) in the investment of any funds not required for immediate disbursement in the purchase of such securities as may be lawful investments for fiduciaries in the

commonwealth; (4) for the payment of binding obligations associated with such qualified investments which are secured by the fund as the same become payable; and (5) for the payment of principal or interest on qualified investments secured by the fund or the payment of any redemption premium required to be paid when such qualified investments are redeemed prior to maturity.

(c) The fund shall be held and applied by the center, subject to the approval of the board, and in consultation with said advisory committee to make qualified investments designed to advance the following public purposes in the commonwealth: (1) to stimulate increased financing for the expansion of state-of-the-art clean energy research and development facilities by leveraging private financing and providing financing related thereto including, without limitation, financing for the construction or expansion of such facilities; (2) to provide grants to state educational institutions to develop a curriculum relative to clean energy and clean energy technology; (3) to make targeted investments in clean energy research and to promote manufacturing activities for new or existing advanced clean energy technologies; (4) to make matching grants to universities, colleges, public instrumentalities, companies and other entities to induce the federal government, industry and other grant-funding sources to fund the expansion of research and development in clean energy; (5) to provide bridge financing to universities, colleges, public instrumentalities, companies and other entities in anticipation of the receipt of grants of the type described in clause (4) awarded or to be awarded by the federal government, industry or other sources; (6) to promote programs and investments that lead to pathways towards economic self-sufficiency for low and moderate-income communities in the clean energy industry; provided, however, that said programs shall prioritize investments that serve individuals in families with incomes that do not exceed 300 per cent of the federal poverty level, as determined by the United States Census Bureau or a self-sufficiency standard, as determined by the executive office of administration and finance that shall include but not be limited to, the income needs of families, family size, the number and ages of children in the family and geographical considerations; and (7) to make any other expenditure provided by this section.
The center shall not make a qualified investment under clause (1) of subsection (b) unless: (i) said qualified investment has been approved by a majority vote of the board; and (ii) the center finds that, to the extent possible, said qualified investment is such that a defined benefit to the economy of the commonwealth may reasonably be expected therefrom; provided, however, that in evaluating a request or application for funding, the center shall consider whether: (1) the proposed project fulfills the public purposes of the center; (2) the project has significant potential to expand clean energy related employment in the commonwealth; (3) the project has the potential to enhance technological advancements in clean energy; (4) the project has the potential to result in the development of advancements in environmental protection and reduce the cost of energy; (5) the project has the potential to leverage additional funding or to attract additional energy resources to the commonwealth; (6) the project has the potential to stimulate clean energy manufacturing in the commonwealth; (7) the project includes a plan to facilitate collaboration with state and local workforce development programs; or (8) the program leads to pathways towards economic self-sufficiency for low and moderate-income communities in the clean energy industry as established provided in clause (6).

B-393

The center shall not make a qualified investment under said clause (1) of said subsection (b) unless such qualified investment is in conformity with rules adopted by the center and approved by the board. Said rules shall set the terms and conditions for investments which constitute qualified investments, which may include, without limitation, loans, guarantees, loan insurance or reinsurance, equity investments, equity ownership in public or private companies, grants made pursuant to clause (4) of subsection (c) or other financing or credit enhancing devices, as made by the center directly or on its own behalf or in conjunction with other public instrumentalities, private institutions or the federal government.

Said rules shall also set forth the terms, procedures, standards and conditions which the center shall employ to identify qualified applications, process applications, make investment determinations, safeguard the fund, advance the objective of increasing employment opportunities in the commonwealth, oversee the progress of qualified investments and secure the participation of other public instrumentalities, private institutions or the federal government in such qualified investments; provided, however, that said rules shall provide for negotiated intellectual property agreements between the center and each recipient of a qualified investment which shall include the terms and conditions by which the fund's support thereof may be reduced or withdrawn; and provided further, that all revenues or financial interests of any kind received by the center as a result of said intellectual property agreements shall be placed, in their entirety, in the fund.
Copies of the approved rules, and any modifications thereto, shall be submitted annually to the clerks of the house of representatives and the senate, who shall forward the same to the chairs of the house and senate committees on ways and means, the chairs of the joint committee on economic development and emerging technologies, the chairs of the joint committee on telecommunication, utilities and energy and the joint committee on environment, natural resources and agriculture.

(d) There shall be an advisory committee to be appointed by the governor consisting of 15 individuals with an interest and knowledge in matters related to the general purpose and activities of the fund and with expertise and experience in at least 1 of the following areas: clean energy technology research, clean energy technology development, clean energy investing, management of clean energy companies, making or advancing clean energy policy, clean energy curriculum development or workforce training in the field of clean energy or energy efficiency. The board shall consult with the advisory committee in matters related to the fund and in the implementation of this section.

(e) Qualified investment transactions undertaken by the center pursuant to this section shall not, except as specified in this section, be subject to chapter 175, and shall not constitute a debt or pledge of the faith and credit of the commonwealth, the center or any subdivision of the commonwealth and shall be payable solely from the Massachusetts Alternative and Clean Energy Investment Trust Fund.

All available moneys in the Massachusetts Alternative and Clean Energy Investment Trust Fund that are unexpended at the end of each fiscal year shall not revert to the General Fund and shall be available for expenditure in the subsequent fiscal year.

B-394

SECTION 2. The General Laws are hereby amended by inserting after chapter 23I the following chapter:-

Chapter 23J
Massachusetts Clean Energy Technology Center

Section 1. As used in this chapter, the following words shall, unless the context clearly requires otherwise, have the following meanings:
“Board”, the board of directors of the center.
“Bonds”, when used in reference to the center, any bonds, notes, debentures, interim certificates or other financial undertakings for the purpose of raising capital, including, but not limited to, lines of credit, forward purchase agreements, investment agreements and other banking or financial arrangements.
“Center”, the Massachusetts clean energy center established by section 2.
“Clean energy”, advanced and applied technologies that significantly reduce or eliminate the use of energy from non-renewable sources, including, but not limited to: energy efficiency; demand response; energy conservation and those technologies powered in whole or in part by the sun, wind, water, biomass, alcohol, wood, fuel cells any renewable, non-depletable or recyclable fuel and for purposes of this Act, an alternative energy generating source as defined in clauses (1) to (5), inclusive, of subsection (a) of section 11F1/2 of chapter 25A.
“Clean energy research”, advanced and applied research in new clean energy technologies including: solar photovoltaic; solar thermal; wind power; geothermal; wave and tidal energy; advanced hydropower; energy storage for automotive applications; energy storage for grid applications; biofuels, including ethanol, biodiesel and advanced biofuels; renewable, biodegradable chemicals; advanced thermal-to-energy conversion; hydrogen; carbon capture and sequestration; energy monitoring; green building materials; energy-efficient lighting; gasification and conversion to liquids fuels; industrial energy efficiency; demand-side management; fuel cells; and other technologies that the board considers to qualify under the definitions herein; provided, however, that “clean energy research” shall not include coal, oil, natural gas except when used in fuel cells or nuclear power.
“Contribution agreement”, an agreement authorized under this chapter in which a private entity or public entity other than the commonwealth agrees to provide to the center contributions for the purpose of promoting clean energy research.
“Federal agency”, an office, agency, division, department, board or commission of the United States government.
“Fund”, the Massachusetts Alternative and Clean Energy Investment Trust Fund established in subsection (a) of section 35FF of chapter 10.
“Person”, a natural or corporate person, including bodies politic and corporate, public departments, offices, agencies, authorities and political subdivisions of the commonwealth, corporations, trusts, societies, associations and partnerships and subordinate instrumentalities of any 1 or more political subdivisions of the commonwealth.

B-395
"Public body", the commonwealth and any body politic and corporate of the commonwealth, including any political subdivision or instrumentality thereof, which is empowered to issue bonds secured by a pledge of revenues or other special funds or assets, including any municipality or district for which the issuance of debt is governed or limited by chapter 44.
"Revenues", any receipts, fees, rentals or other payments or income received or to be received on account of obligations to the center including, without limitation: equity ownership in public or private companies; income on account of the leasing, mortgaging, sale or other disposition of a project or proceeds of a loan made by the center in connection with any project; and amounts in reserves or held in other funds or accounts established in connection with the issuance of bonds and the proceeds of any investments thereof; proceeds of foreclosure; and any other fees, charges or other income received or receivable by the center.

Section 2. (a) There is hereby established a body politic and corporate to be known as the Massachusetts clean energy technology center. The center is hereby constituted a public instrumentality and the exercise by the center of the powers conferred by this chapter shall be considered to be the performance of an essential governmental function.
The center is hereby placed in the executive office of energy and environmental affairs, but shall not be subject to the supervision or control of said office, or of any board, bureau, department or other center of the commonwealth, except as specifically provided for in this chapter.
The center shall promote and advance the commonwealth's public interests by: (i) acting as the commonwealth's lead agency, in collaboration with the Massachusetts Renewable Energy Trust Fund established in section 4E of chapter 40J, in the promotion and development of jobs in the clean energy sector; (ii) promoting research and workforce training in clean energy technology at the commonwealth's public institutions of higher education, as defined in section 5 of chapter 15A, and vocational technical schools, as established in sections 14 and 15, chapter 74 or any vocational technical school that meets the programmatic requirements established by the department of elementary and secondary education; (iii) stimulating the creation and development of new clean energy ventures that will form the foundation of a strong clean energy industry sector or cluster in the commonwealth; (iv) providing support to existing clean energy companies to expand their operations within the commonwealth; (v) attracting new capital and research facilities from institutions outside the commonwealth; (vi) fostering collaboration between industry, state government, research universities and the financial sector to advance clean energy technology commercialization and venture development; (vii) conducting market research to identify barriers to creating and expanding a clean technology industry, including job training needs; (viii) supporting demonstration projects that are evaluated by independent, third-party peer research institutions; (ix) serving as the clearinghouse for information related to the clean energy industry in the commonwealth; (x) promoting programs and investments that lead to pathways towards economic self sufficiency for low and moderate-income individuals and communities in the clean energy industry; and (xi) performing any other actions necessary to effectuate the state's public interests.
(b) The center shall be governed and its corporate powers exercised by a board of directors consisting of 14 directors: 1 of whom shall be the secretary of energy and environmental affairs or his designee;

B-396
1 of whom shall be the secretary of housing and economic development or his designee; 1 of whom shall be the secretary of labor and workforce development or his designee; 1 of whom shall be the president of the University of Massachusetts or his designee; 1 of whom shall be a chair of the New England Clean Energy Council; 1 of whom shall be the chair of the Massachusetts Renewable Energy Trust; 1 of whom shall be the executive director of the Massachusetts Technology Collaborative; 1 of whom shall be the executive director of the Massachusetts Workforce Alliance; and 6 of whom shall be appointed by the governor, 2 of whom shall be presidents of private colleges or universities in the commonwealth or their designees, 1 of whom shall be an engineer or scientist with expertise in clean energy technology, 1 of whom shall be a venture capitalist with expertise in clean energy technologies in the commonwealth, 1 of whom shall be the president of a Massachusetts community college or his designee, and 1 of whom shall be a chief executive officer of a Massachusetts-based clean energy corporation. Each of the 6 directors appointed by the governor shall serve for a term of 5 years, except that in making his initial appointments, the governor shall appoint 1 director to serve for a term of 1 year, 1 director to serve for a term of 2 years, 1 director for a term of 3 years, 1 director for a term of 4 years and 2 directors for a term of 5 years. The secretary of energy and environmental affairs or his designee shall serve as chairperson. A director shall be eligible for reappointment. A director may be removed from his appointment by the governor for cause. A person appointed to fill a vacancy in the office of an appointed director of the board shall be appointed in a like matter and shall serve for only the unexpired term of such director.

(c) Six directors shall constitute a quorum and the affirmative vote of a majority of directors present at a duly-called meeting where a quorum is present shall be necessary for any action to be taken by the board. An action required or permitted to be taken at a meeting of the directors may be taken without a meeting if all of the directors consent in writing to such action and such written consents are filed with the records of the minutes of the meeting of the board. Such consents shall be treated for all purposes as a vote at a meeting.

The directors of the board shall serve without compensation, but each director shall be entitled to reimbursement for his actual and necessary expenses incurred in the performance of his official duties.

(d) Chapter 268A shall apply to all directors.

(e) The board may appoint and employ an executive director, and fix his compensation and conditions of employment. The executive director shall have a full range of previous experience in the clean energy industry, including previous executive experience within the clean energy industry. The executive director shall be the chief executive, administrative and operational officer of the center and shall direct and supervise the administrative affairs and the general management of the center. The executive director may, subject to the general supervision of the board, employ other employees, consultants, agents, including legal counsel and advisors, and shall attend meetings of the board.

(f) The board shall elect a secretary and a treasurer. The secretary shall keep a record of the proceedings of the board and shall be the custodian of all books, documents and papers filed by the board and of its minute book and seal. The secretary shall cause copies to be made of all minutes and other records and documents of the center and shall certify that such copies are true copies, and all

persons dealing with the center may rely upon such certification. The treasurer shall be the chief financial and accounting officer of the center and shall be in charge of its funds, books of account and accounting records. The books and records of the center shall be subject to a biennial audit by the auditor of the commonwealth.
(g) All officers and employees of the center having access to its cash or negotiable securities shall give bond to the center, at its expense, in such amounts and with such surety as the board may prescribe. The persons required to give bond may be included in 1 or more blanket or scheduled bonds.
(h) The directors and officers of the board who are not compensated employees of the center shall not be liable to the commonwealth, to the center or to any other person as a result of their activities, whether ministerial or discretionary, as such directors or officers except for willful dishonesty or intentional violations of law. Neither members of the center nor any person executing bonds or policies of insurance shall be liable personally thereon or be subject to any personal liability or accountability by reason of the issuance thereof. The board of directors may purchase liability insurance for board members, officers and employees and may indemnify said persons against claims by others.
(i) The center shall continue as long as it shall have bonds or insurance or guarantee commitments outstanding and until its existence is terminated by law. Upon the termination of the existence of the center, all rights, title and interest in and to its assets and its obligations, duties, covenants, agreements and obligations shall vest in and be possessed, performed and assumed by the commonwealth.
(j) An action of the center may take effect immediately and need not be published or posted unless otherwise provided by law. Meetings of the board shall be subject to section 11A1/2 of chapter 30A; but said section 11A1/2 shall not apply to any meeting of members of the center serving ex officio in the exercise of their duties as officers of the commonwealth so long as no matters relating to the official business of the center are discussed and decided at the meeting. The center shall be subject to all other provisions of said chapter 30A, and records pertaining to the administration of the center shall be subject to section 42 of chapter 30 and section 10 of chapter 66. All moneys of the center shall be considered to be public funds for purposes of chapter 12A. The operations of the center shall be subject to chapters 268A and 268B and all other operational or administrative standards or requirements to the same extent as the office of state treasurer.
(k) Any documentary materials or data whatsoever made or received by a member or employee of the center and consisting of, or to the extent that such materials or data consist of, trade secrets or commercial or financial information regarding the operation of any business conducted by an applicant for any form of assistance which the center is empowered to render or regarding the competitive position of such applicant in a particular field of endeavor, shall not be deemed public records of the center and shall not be subject to section 10 of chapter 66. Any discussion or consideration of such trade secrets or commercial or financial information may be held by the board in executive sessions closed to the public, notwithstanding section 11A1/2 of chapter 30A, but the purpose of any such executive session shall be set forth in the official minutes of the center and no business which is not directly related to such purpose shall be transacted nor shall any vote be taken during such executive session.

B-398

Section 3. (a) The center shall have all powers necessary or convenient to carry out and effectuate its purposes, including, without limiting the generality of the foregoing, the powers:
(1) to adopt and amend by-laws, regulations and procedures for the governance of its affairs and the conduct of its business, notwithstanding chapter 30A;
(2) to establish standards requiring that any grant, loan or other appropriation of funds pursuant to this chapter be subject to an intellectual property agreement between the center and the recipient person; provided, however, that said intellectual property agreements shall balance the opportunity for the commonwealth to benefit from the patents, royalties and equity ownership in public and private companies and licenses with the need to ensure that essential clean energy research shall not be unreasonably hindered by the intellectual property agreements; and provided further, that all revenues or financial interests of any kind received by the center as a result of said intellectual property agreements shall be placed, in their entirety, in the fund.
(3) to adopt an official seal;
(4) to maintain offices within the commonwealth as it may determine and to conduct meetings of the center in accordance with the by-laws of the center and the second paragraph of section 59 of chapter 156B;
(5) to sue and be sued, to prosecute and defend actions relating to its properties and affairs and to be liable in tort in the same manner as a private person; provided, however, that the center is not authorized to become a debtor under the United States Bankruptcy Code;
(6) to appoint officers and employees and to engage consultants, agents and advisors;
(7) to enter into contracts and agreements and execute all instruments necessary or convenient thereto for accomplishing the purposes of this chapter; provided, however, that such contracts and agreements may include, without limiting the foregoing, construction agreements, purchase or acquisition agreements, loan or lease agreements, partnership agreements including limited partnership agreements, joint ventures, participation agreements, service agreements with clean energy entities, environmental, educational or other financial institutions or intermediaries and agreements with 1 or more persons for the servicing of loans made by the center, including the receipt by such servicer of payments made by a user under a financing document and provided further, that any such payments shall constitute trust funds to be held and applied solely as provided in such agreement for the servicing of loans, shall constitute pledged funds of the center and shall be entitled to the same protection when received by a person for the servicing of loans, without the need for filing and recording of the servicing agreement under chapter 106 or otherwise, except in the records of the center, as is afforded to funds received by an issuer and pledged to a trustee under section 14 of chapter 40D;
(8) to acquire real and personal property, or any interest in real or personal property, by gift, purchase, transfer, foreclosure, lease or otherwise including rights or easements; to hold, sell, assign, lease, encumber, mortgage or otherwise dispose of any real or personal property, or any interest therein, or mortgage any interest owned by it or under its control, custody or in its possession; to release or relinquish any right, title, claim, lien, interest, easement or demand however acquired, including any equity or right of redemption in property foreclosed by it; to take assignments of leases and rentals,

proceed with foreclosure actions or take any other actions necessary or incidental to the performance of its corporate purposes;
(9) to invest funds held in reserves or sinking funds, or the Massachusetts Alternative and Clean Energy Investment Trust Fund, or funds not required for immediate disbursement, in such investments as may be provided in a financing document relating to the use of such funds, or, if not so provided, as the board may determine;
(10) to review and recommend changes in laws, rules, programs and policies of the commonwealth and its agencies and subdivisions to further the enhancement of clean energy financing, infrastructure, siting, manufacturing and development within the commonwealth;
(11) to appear on its own behalf before boards, commissions, departments or other agencies of municipal, state or federal government;
(12) to obtain insurance;
(13) to apply for and accept subventions, grants, loans, advances and contributions from any source of money, property, labor or other things of value, to be held, used and applied for its corporate purposes; provided, however, that the center shall not accept funding from any source, including any federal agency, if the receipt of said funding would limit the center's ability to promote its public purposes; and provided further, that all such funds shall be placed, in their entirety, in the fund;
(14) to enter into agreements with public and private entities that deal primarily with clean energy technologies, in order to distribute and provide leveraging of monies or services for the purposes of furthering research and development, aiding in the promotion of environmental protection, creating jobs in clean energy and promoting overall economic growth by fostering collaboration and investments in clean energy in the commonwealth;
(15) to provide and pay for such advisory services and technical assistance as may be necessary or desired to carry out the purposes of this chapter;
(16) to establish and collect such fees and charges as the center without further appropriation shall determine to be reasonable, and to receive and apply revenues from fees and charges to the purposes of the center or allotment by the commonwealth or any political subdivision thereof; provided, however, that all said revenues shall be placed, in their entirety, in the fund;
(17) to make loans to any person for the acquisition, construction, alteration or any combination thereof, or other financing of a project including, but not limited to, loans to lending institutions under terms and conditions requiring the proceeds of such loans to be used by such lending institutions for the making of loans to users for qualified projects;
(18) to disburse, appropriate, grant, loan or allocate funds for the purposes of investing in clean energy as directed in this chapter;
(19) to provide assistance to local entities and authorities, public bodies and private corporations for the purposes of maximizing opportunities for expanding clean energy technologies, attracting new clean energy entities and advanced technology investments, fostering new innovative research and creating new manufacturing and development initiatives in the commonwealth;
(20) to prepare, publish and distribute, with or without charge, as the center may determine, such studies, reports and bulletins and other material as the center deems appropriate;

B-400

(21) to exercise any other powers of a corporation organized under chapter 156B;
(22) to engage accountants, architects, attorneys, engineers, planners, real estate experts and other consultants as may be necessary in its judgment to carry out the purposes of this act and to fix their compensation;
(23) to take any actions necessary or convenient to the exercise of any power or the discharge of any duty provided for by this chapter;
(24) to enter into agreements or other transactions with any person, including without limitation any public entity or other governmental instrumentality or agency in connection with its powers and duties under this chapter;
(25) to make qualified investments to ensure the success of clean energy industry clusters;
(26) to institute and administer the Massachusetts Alternative and Clean Energy Investment Trust Fund for the purposes of making appropriations, allocations, grants or loans to leverage development and investments in clean energy research, workforce training and job creation; provided, however, that the center shall implement an application and grant process for these purposes;
(27) to promote programs and investments that lead to pathways towards economic self-sufficiency for low and moderate-income individuals and communities in the clean energy industry;
(28) to research and establish, if the center so chooses, the Massachusetts Hydrogen and Fuel Cell Institute, to be housed at the Worcester Polytechnic Institute, and to serve as a joint venture among institutes of higher education in the commonwealth providing a focal point for research, education and commercialization activities in the hydrogen fuel cell sector; provided, however, that said institute responsibilities may include, but not be limited to: (i) working with the University of Massachusetts and private higher education institutions in the commonwealth to coordinate and strengthen hydrogen and fuel cell research activities in the commonwealth; (ii) strengthening collaborative research and development between universities and companies located within the commonwealth; (iii) addressing critical technological barriers facing the hydrogen and fuel cell companies; (iv) strengthening existing educational programs and introducing new curriculum in Massachusetts universities to produce graduates who are conversant in hydrogen and fuel cell technologies; and (5) promoting partnerships between Massachusetts universities and companies to jointly demonstrate hydrogen and fuel cell technologies and attract greater amounts of federal funding to the commonwealth;
(29) to allocate, if the center so chooses, up to $2 million annually for 5 years for the Massachusetts Hydrogen and Fuel Cell Institute; provided, however, that said funding shall begin in the fiscal year that said institute shall be established and shall end in the fifth fiscal year following the establishment of said institute; and
(30) to establish, if the center so chooses, a program to be known as the entrepreneurial fellowship program, which shall award grants to entrepreneurs from business sectors other than clean energy sectors to enroll in programs to foster knowledge and expertise of clean energy technology; provided, however, that the clean energy technology programs shall be based upon intensive technology, market and policy curriculum and; provided, further, that the center shall establish public-private partnerships and enter into contribution agreements with commonwealth-based companies and venture capitalists to support programs designed to mentor and train entrepreneurs from other business sectors in the areas of clean energy technology and development to increase investment in

B-401
the commonwealth's clean energy sector.

Section 4. (a) The exercise of the powers granted by this chapter shall be in all respects for the benefit of the people of the commonwealth and for the improvement of their health and living conditions. The operation of the center shall constitute the performance of essential governmental functions and the center shall not be required to pay any taxes or assessments, except as otherwise provided by this chapter and the notes or bonds issued under this chapter, their transfer and the income therefrom, including any profit made on the sale thereof shall be free from taxation by and within the commonwealth.
(b) The lands and tangible personal property of the center shall be deemed to be public property used for essential public and governmental purposes and shall be exempt from taxation and from betterments and special assessments.

Section 5. The center shall annually submit a report setting forth, relative to its operations, its receipts and expenditures during such fiscal year and its assets and liabilities during the fiscal year to the governor, the secretary of administration and finance, the comptroller and the clerks of the house of representatives and senate, who shall forward the same to the house and senate committees on ways and means, the joint committee on economic development and emerging technologies, the joint committee on telecommunications, utilities and energy and the joint committee on environment, natural resources and agriculture annually on or before June 1.

Section 6. Based on recommendations included in the clean energy study, the center shall, within 100 days of said study's completion, develop a statewide plan for the installation and operation of renewable energy generating facilities on real property owned by the commonwealth. Any renewable energy generating facility sited on state land shall be made available for state and local workforce development and training initiatives.

Section 7. There is hereby established and placed within the center a program to be known as the clean energy seed grant program. Said program shall award grants to clean energy researchers, companies, nonprofit organizations, community-based organizations and institutions. The center shall establish public-private partnerships with commonwealth-based investors, entrepreneurs and institutions that are involved in the clean energy industry for the purposes of facilitating matching grants for recipients of funding from the center.

Section 8. There is hereby established and placed within the center an initiative to be known as the green jobs initiative. Said initiative shall award grants to the commonwealth's public institutions of higher education as defined in section 5 of chapter 15A, and vocational technical schools, as established in sections 14 and 15 of chapter 74 or any vocational-technical school that meets the programmatic requirements established by the department of elementary and secondary education, to facilitate workforce development efforts and train and retain students in clean energy industries. The grants shall include matching grants to said public institutions of higher education and said vocational

B-402

technical schools for the development of small-scale renewable energy generating sources, including, but not limited to: photovoltaic installations; wind energy; ocean thermal, wave or tidal energy; fuel cells; landfill gas; natural flowing water and hydroelectric; low-emission advanced biomass power conversion technologies using such biomass fuels as wood, agricultural or food wastes; biogas, biodiesel or organic refuse-derived fuel; and geothermal energy. The center shall assist said public institutions of higher education as defined in this section and the commonwealth's vocational technical schools as defined in this section in developing a curriculum for clean energy and energy efficiency, and shall assist students seeking employment in the clean energy sector.

SECTION 3. Section 4B of chapter 40J of the General Laws, as appearing in the 2006 Official Edition, is hereby amended by striking out, in line 35 and 36, the word "inducing" and inserting in place thereof the following words:- working in collaboration with the Massachusetts clean energy technology center established in section 2 of chapter 23J, state to induce.

SECTION 4. Said section 4B of said chapter 40J, as so appearing, is hereby further amended by inserting after the word "industries", in line 39, the following words:- , the Massachusetts clean energy technology center.

SECTION 5. Subsection (b) of section 4E of said chapter 40J, as so appearing, is hereby amended by adding the following sentence:- The board shall consult with the Massachusetts clean energy technology center established in section 2 of chapter 23J, prior to making any funds available to said renewable energy projects and facilities for the purpose of clean energy job creation.

SECTION 6. Said section 4E of said chapter 40J, as so appearing, is hereby further amended by inserting after the word "technologies", in line 41, the following words:- by collaborating with the Massachusetts clean energy technology center established in section 2 of chapter 23J.

SECTION 7. Subsection (d) of said section 4E of said chapter 40J, as so appearing, is hereby amended by adding the following sentence:- In developing and revising said plan, the board shall consult with the Massachusetts clean energy technology center established in section 2 of chapter 23J to ensure a comprehensive and effective approach to clean energy job creation.

SECTION 8. Subsection (a) of section 6A of said chapter 40J, as so appearing, is hereby amended by inserting after the eighth sentence the following sentence:- The governing board shall consult with the Massachusetts clean energy technology center established in section 2 of chapter 23J, to ensure a comprehensive and effective approach to clean energy cluster growth and development.

SECTION 9. The state comptroller shall annually transfer from the Massachusetts Renewable Energy Trust Fund, established in section 4E of chapter 40J of the General Laws, not less than $5,000,000 annually for deposit in the Massachusetts Alternative and Clean Energy Investment Trust Fund

B-403

established in section 35FF of chapter 10. The secretary of energy and environmental affairs may allocate up to 15 per cent of said $5,000,000 in fiscal year 2009 to defray the ordinary and necessary expenses of administration and operation associated with the center.

SECTION 10. The secretary of energy and environmental affairs may allocate $1,000,000 in fiscal year 2009 from the Massachusetts Alternative and Clean Energy Investment Trust Fund for a seed grant program to be administered by the secretary or his designee. Said seed grant program shall award grants to clean energy companies, institutions or nonprofit organizations.

A report detailing the expenditure of said $1,000,000 shall be submitted on or before May 30, 2009 to the clerks of the house of representatives and the senate, who shall forward the same to the chairs of the house and senate committees on ways and means, the chairs of the joint committee on economic development and emerging technologies, the chairs of the joint committee on telecommunication, utilities and energy, and the joint committee on environment, natural resources and agriculture.

SECTION 11. The secretary of energy and environmental affairs, in consultation with the secretary of labor and workforce development, may allocate $1,000,000 in fiscal year 2009 from the Massachusetts Alternative and Clean Energy Investment Trust Fund, established by section 35FF of chapter 10 of the General Laws, for a workforce development grant program to be administered by the secretary or his designee. Said program shall award grants to the commonwealth's higher education institutions, vocational technical schools, or community-based organizations that have existing workforce development programs in clean energy industry skills or the capacity to create such programs.

A report detailing the expenditure of said $1,000,000 shall be submitted on or before May 30, 2009 to the clerks of the house of representatives and the senate, who shall forward the same to the chairs of the house and senate committees on ways and means, the chairs of the joint committee on economic development and emerging technologies, the chairs of the joint committee on telecommunication, utilities and energy, and the joint committee on environment, natural resources and agriculture.

SECTION 12. The secretary of energy and environmental affairs may allocate $100,000 in fiscal year 2009 from the Massachusetts Alternative and Clean Energy Investment Trust Fund, established by section 35FF of chapter 10 of the General Laws, to commission a study to investigate the clean energy sector in the commonwealth. The study shall include, but not be limited to, an examination of: (i) the future workforce needs of the commonwealth's clean energy sector; (ii) the current growth rate of said sector, including the number of in state jobs and businesses; (iii) the current levels of private investment in said sector; (iv) real property owned by the commonwealth available and suited for the installation and operation of renewable energy generating facilities; (v) energy efficiency opportunities on real property owned by the commonwealth; and (vi) the future funding requirements of the center.

A copy of said study shall be submitted on or before February 1, 2009 to the clerks of the house of

B-404

representatives and the senate, who shall forward the same to the chairs of the house and senate committees on ways and means, the chairs of the joint committee on economic development and emerging technologies, the chairs of the joint committee on telecommunication, utilities and energy, and the joint committee on environment, natural resources and agriculture.

SECTION 13. The secretary of energy and environmental affairs in consultation with the secretary of labor and workforce development may allocate $1,000,000 from the Massachusetts Alternative and Clean Energy Investment Trust Fund, established by section 35FF of chapter 10 of the General Laws, for an initiative to be known as the pathways out of poverty initiative. Said initiative shall be administered by said secretary or his designee. Under said initiative, the secretary shall award 5 competitive grants to clean energy companies, community-based nonprofit organizations, educational institutions or labor organizations to enable said entities to carry out training programs associated with the clean energy industry that lead to economic self-sufficiency. The center shall give funding priority to entities that serve individuals in families with incomes that do not exceed 300 per cent of the poverty level, as determined by the United States Census Bureau, or a self-sufficiency standard for the local areas where the training is conducted that specifies the income needs of families, family size, the number and ages of children in the family and geographical considerations.

Said grants shall be awarded so as to ensure geographic diversity within the commonwealth with consideration given to the commonwealth's gateway cities, which shall include Brocton, Fall River, Fitchburg, Haverhill, Holyoke, Lawrence, Lowell, New Bedford, Pittsfield, Springfield and Worcester. A report detailing the expenditure of said $1,000,000 shall be submitted on or before May 30, 2009 to the clerks of the house of representatives and the senate, who shall forward the same to the chairs of the house and senate committees on ways and means, the chairs of the joint committee on economic development and emerging technologies, the chairs of the joint committee on telecommunication, utilities and energy, and the joint committee on environment, natural resources and agriculture..

Approved August 12 , 2008

Appendix C:
Independent Reports and Documents

Massachusetts 2008 Energy Bill

An Act Relative to Green Communities, Senate Bill No. 2768

June 25, 2008

Environment Northeast

This summary by Environment Northeast (ENE) of Massachusetts Senate Bill No. 2768, *An Act Relative to Green Communities,* focuses on the environmental and energy efficiency elements. The bill was released by the conference committee on June 23, and reconciles the differences between the Senate version, passed on January 9, 2008, and the House version, passed on November 14, 2007. It was approved unanimously by both houses of the legislature—the Senate on June 24, 2008 and the House on June 26, 2008—and signed into law by Governor Patrick on July 2, 2008.

The bill significantly reforms the state's energy policy, and makes a large new commitments to electric and natural gas energy efficiency programs, renewables, and clean fossil fuels like combined heat and power. It includes virtually all of ENE's highest priority policy recommendations for utility reform and efficiency and clean energy investments. These provisions may be supplemented by parallel proceedings to decouple utility revenue from sales ongoing at the Department of Public Utilities.

Summary of Major Bill Provisions

- ***Electric Energy Efficiency and Demand Resources:*** The bill requires electric distribution utilities to increase investments in energy efficiency and demand resource programs for all customers by: mandating investment in all demand side resources that are cost-effective or cheaper than supply; reducing consumers' energy bills; reducing emissions; and, reducing our reliance on imported fossil fuels.

  The efficiency mandates are a remarkable achievement that puts Massachusetts in position to save its consumers hundreds of millions of dollars and substitute energy service jobs for fossil fuel expenditures. Currently, the state spends about $6 billion dollars to buy electricity that costs at least 10 cents/kwh and only $150 million on home grown energy efficiency, which can be delivered at 3 cents/kwh. The new regime introduced by this bill will rebalance the ledger by ensuring that the state invests in all energy efficiency and demand side resources that are cost-effective or cheaper than supply.

- ***Natural Gas Energy Efficiency:*** The natural gas distribution utilities are also required to increase their investments in energy efficiency programs for all customers to ensure that all cost-effective energy efficiency is captured. This will reduce consumers' energy bills, reduce emissions, and reduce our reliance on imported fossil fuels.

- ***Energy Efficiency Program Design and Oversight:*** A new oversight Council is established to ensure that demand resource plans maximize economic benefits to consumers. The Council will be comprised of a broad array of stakeholder constituencies including low-income, commercial and industrial, manufacturing, environmental and efficiency experts. The Council will provide essential oversight and will improve and enhance the utility-administered energy efficiency programs. The Council will have the benefit of hiring expert consultants to make sure efficiency programs are designed to maximize customer savings and cost-effectiveness.

- ***Regional Greenhouse Gas Initiative:*** This bill authorizes 100% auction of all RGGI allowances and directs proceeds to five uses: promotion of energy efficiency and demand response (minimum of 80% of revenue); reimbursement of municipalities in which tax receipts decrease due to RGGI (limited to 3 years); green communities (not to exceed $10 million per year); zero-interest loans to some municipalities for efficiency projects; and, state administration of the cap and trade program.

- ***Renewable Portfolio Standard***: The RPS has been divided into two classes. Class I includes new solar, wind, new and incremental hydro, and low-emission advanced biomass technologies. The bill sets a target that Class I resources should account for 15% of MA energy sales by 2020. Class II eligible technologies

includes existing low-emission biomass and existing hydro; targets for Class II RPS requirements will be set by Division of Energy Resources. Expanding the RPS uses the competitive marketplace to ensure that a larger slice of Massachusetts' electric energy comes from renewable sources.

- ***Long Term Renewable Contracting:*** As part of a 5 year pilot program, utilities are mandated to enter into long term contracts of 10-15 years in length for up to 3% of their total load. This is intended to spur construction and financing of new renewables.
- ***Alternative Energy Portfolio Standard (AEPS)***: The development of the AEPS in Massachusetts was a controversial and complicated process that began with an attempt to insert fossil fuel technologies into the RPS. The creation of the AEPS preserves the integrity of the RPS, limiting it to renewable technologies, and creates a competitive, market-based system for new non-renewable electric supply sources. The portfolio standard supports combined heat and power, gasified coal with carbon capture and permanent sequestration, flywheel, energy efficient steam technology and paper cube technology. It sets carbon dioxide emissions standards that must be reviewed every two years. The AEPS has a strict emissions limit that will require significant carbon capture and sequestration (CCS) from coal or petroleum based sources, which for coal should require about half of the carbon to captured and permanently sequestered. ENE had hoped this emissions limit would be even stronger than the natural gas power plant average (currently in the range of 1,000-1,200 lbs/MWh), and we will work to have this standard tightened over time. Coal with CCS will also have to compete against more mature technologies, such as combined heat and power (CHP), which are more suitable for many locations in Massachusetts. ENE is optimistic that the AEPS will create a significant incentive for the development of new CHP in Massachusetts, which will help the state reduce its energy consumption and emissions.
- ***Building Energy Codes***: The bill requires the Board of Building Regulations and Standards (BBRS) to adopt the latest edition of the IECC energy code, and to update its code within 1 year of any IECC revision. In addition, the BBRS must develop regulations: (1) to require all new construction and major renovations comply with the energy conservation code; (2) to certify and train energy inspectors; and, (3) to require energy performance commissioning for all new and renovated large, non-residential buildings.
- ***Home Energy Scoring:*** The bill requires the Board of Registration of Home Inspectors to develop requirements that home buyers be given documents outlining the procedures and benefits of home energy audits at the time of sale.
- ***Green Communities***: The bill creates the Green Communities program, aimed at providing financial assistance (through award grants, loans and financing assistance) for a variety of efficiency and conservation projects at the municipal level. In addition, the Green Communities program is aimed at spurring cities and towns to take steps to reduce and improve the efficiency of their energy use. In order to qualify for financial assistance, the town must agree to a streamlined permitting process for new renewable projects. Funding for the Green Communities program will come, in part, from the sale of RGGI auction allowances, the Renewable Energy Trust Fund, and from Alternative Compliance Payments relating to Renewable Portfolio Standards.
- ***Net Metering***: The bill establishes provisions around net metering, mandating that the aggregate capacity of net metering shall not exceed 1 percent of a distribution company's peak load. The department will continue to remove any impediments to the development of efficient, low-emissions distributed generation.

Detailed Bill Summary by Section

SECTION 1. Requires the state, to the maximum extent feasible, to purchase hybrid or alternative fuel vehicles, with a goal of having at least 50% of the state's fleet be hybrid or alternative fuel vehicles by 2018.

SECTION 2. Requires all new or renovated state facilities with costs over $25,000 to conduct construction in a manner that minimizes life-cycle costs through energy efficiency, renewables, and water conservation.

SECTION 3. Creates the RGGI Auction Trust Fund into which RGGI auction proceeds shall be deposited.

SECTION 4. Creates the Office of Ratepayer Advocacy within the Attorney General's office, with the purpose of intervening, appearing and participating in utility regulatory, administrative and judicial proceedings on behalf of customers.

SECTION 5. Requires the Board of Registration of Home Inspectors to develop regulation to require that single family or multiple-unit (up to 5) residential home buyers receive documentation outlining the procedures and benefits of a home energy audit at the time of sale.

SECTION 6. Technical change.

SECTION 7. Requires EOEEA to design and implement a bidding process for the competitive procurement of electric generation for any state agency or authority.

Regional Greenhouse Gas Initiative:

a. Requires the DPU to adopt the RGGI cap and trade program.
b. Authorizes the sale of all RGGI allowances.
c. Directs proceeds to five uses: (1) reimbursement of municipalities in which the tax receipts decrease due to RGGI; (2) green communities; (3) zero interest loans to certain municipalities for efficiency projects; (4) promotion of energy efficiency and demand response; and (5) state administration of the cap and trade program.
d. Permits the state to participate in a regional cap and trade program.

SECTION 8. Permits the Economic Assistance Coordinating Council under the Department of Economic Development to designate areas determined by a municipality to be an area with development potential for Class I renewable generation sources as an "economic target area."

SECTION 9. Allows the DPU to conduct periodic audits of all regulated utility companies (except steam distribution companies), including a review of financial statements, documentation of reconciling mechanisms and service quality measures. Allows the attorney general to request a DPU audit.

SECTION 10. Allows the DPU to make an annual assessment against each steam distribution company of up to $600,000 for operation and general administration of the department.

SECTION 11. ***Electric Energy and Natural Gas Efficiency and Demand Resources:***

a. Establishes funding streams for electric distribution utilities that will allow increased investments in energy efficiency and demand resource programs including (1) preservation of the 2.5 mill systems benefit charge; (2) amounts generated from the Forward Capacity Market; (3) at least 80% of RGGI auction proceeds; (4) NOx Allowance Trading Program proceeds; (4) other funding as approved by the DPU.
b. Requires the DPU to approve and fund gas efficiency programs, including CHP and geothermal heating and cooling projects.
c. Efficiency funding shall be allocated equitably by customer class, but low-income sub-class shall receive at least 10% of the electric efficiency program funds and at least 20% of the gas efficiency program funds.

d. Preserves the 0.5 mill systems benefit charge for renewable energy development.
e. Allows certain municipal lighting plants to elect to install a systems benefit charge for renewable energy development.
f. Requires electric and gas distribution utilities to increase investments in energy efficiency and demand resource programs for all customers by mandating that all demand side resources that are cost-effective or cheaper than supply be captured, reducing consumers' energy bills, reducing emissions, and reducing our reliance on imported fossil fuels.
g. Requires utility efficiency investment plans every 3 years. Proposed programs must be cost-effective.

Energy Efficiency Program Design and Oversight: a new oversight Council is established to ensure that demand resource plans maximize economic benefits to consumers. The Council is comprised of a 11 voting members, from the following stakeholder constituencies: (1) residential consumers, (2) the low-income weatherization and fuel assistance program network, (3) the environmental community, (4) businesses, including large C&I end-users, (5) the manufacturing industry, (6) energy efficiency experts, (7) organized labor, (8) the department of environmental protection, (9) the attorney general, (10) the executive office of housing and economic development, and (11) the department of energy resources. The Council will have the ability hire independent technical consultants.

SECTION 12. Renames and reorganizes the Division of Energy Resources. DOER will be divided into 3 divisions: (1) energy efficiency; (2) renewable and alternative energy development; and (3) green communities.

SECTION 13. Requires DOER Commissioner to file an annual report to the General Court.

SECTION 14. Technical change.

SECTION 15. Technical change.

SECTION 16. Technical change.

SECTION 17. Technical change.

SECTION 18. Technical change.

SECTION 19. Technical change.

SECTION 20. Technical change.

SECTION 21. Technical change.

SECTION 22. ***Green Communities***: creates the Green Communities program, aimed at providing financial assistance (through award grants, loans and financing assistance) for a variety of efficiency and conservation projects at the municipal level. In addition, the Green Communities program is aimed at spurring cities and towns to taking proactive steps to reduce and improve the efficiency of their energy use. In order to qualify for financial assistance, the town must agree to a streamlined permitting process for new renewable projects. Funding for the Green Communities program will come, in part, from the sale of RGGI auction allowances, the Renewable Energy Trust Fund, and from Alternative Compliance Payments relating to Renewable Portfolio Standards. Funding of Green Communities program is capped at $10 million per year.

SECTION 23. Allows state agencies, building authorities and local government bodies to enter into contracts for the procurement of energy management services, and sets out a process to enter into such contracts.

SECTION 24. Technical change.

SECTION 25. Technical change.

SECTION 26. Technical change.

SECTION 27. Technical change.

SECTION 28. Technical change.

SECTION 29. Technical change.

SECTION 30. Technical change.

SECTION 31. Technical change.

SECTION 32. ***Renewable Portfolio Standard***: the RPS has been divided into two classes. Class I is dedicated to new renewables (beginning operation after December 31, 1997) and includes (1) solar photovoltaic or solar thermal electric energy; (2) wind energy; (3) ocean thermal, wave or tidal energy; (4) fuel cells utilizing renewable fuels; (5) landfill gas; (6) energy generated by new hydroelectric facilities, or incremental new energy from increased capacity or efficiency improvements at existing hydroelectric facilities; (7) low emission advanced biomass power conversion technologies; (8) marine or hydrokinetic energy; or (9) geothermal energy. The target for Class I resources is increased to 15% of MA energy sales by 2020.

Class II is dedicated to existing rewewables (beginning operation before December 31, 1997) and includes (1) solar photovoltaic or solar thermal electric energy; (2) wind energy; (3) ocean thermal, wave or tidal energy; (4) fuel cells utilizing renewable fuels; (5) landfill gas; (6) energy generated by existing hydroelectric facilities; (7) waste-to-energy (but only if it contracts for a state-approved recycling program); (8) low emission advanced biomass power conversion technologies; (9) marine or hydrokinetic energy; or (10) geothermal energy. Targets for Class II RPS requirements will be set by Division of Energy Resources.

Alternative Energy Portfolio Standard: beginning on January 1, 2009 all electric energy sold in the state must have a minimum percentage supplied from AEPS qualified sources. The percentage will be set by DOER through an administrative proceeding. Technologies that qualify for the standard shall include: fossil fuels that are gasified and utilize carbon capture and permanent sequestration (level of CCS based on the net emissions standard); combined heat and power; flywheel energy storage; Paper derived fuel that is deemed by DEP to provide environmental benefits; energy efficient steam technologies; and other technologies to be determined by DOER. There are limit on fossil fuels qualifying and nuclear can not qualify.

There is an explicit emissions limit that will require significant carbon capture and sequestration from any coal or petroleum based sources: the CO_2 emissions limit must be at least as stringent as the average emissions rate of natural gas fired power plants in the state; the CO_2 emissions limit shall be on a net basis including all emissions associated with gasification, sequestration, and combustion, which will require approximately one-half capture and permanent sequestration of CO_2 from coal; for combined heat and power the emissions limit shall be based on both electric and thermal output; and the exact standard will be set by DOER in consultation with DEP and shall be reviewed and strengthened every two years. An alternative compliance payment shall be set by DOER

SECTION 33. Technical change.

SECTION 34. Technical change.

SECTION 35. Technical change.

SECTION 36. Technical change.

SECTION 37. Provides for an alternative mechanism for state agencies, building authorities and local government bodies to enter into energy management services contracts.

SECTION 38. Technical change.

SECTION 39. Technical change.

SECTION 40. Technical change.

SECTION 41. Technical change.

SECTION 42. Technical change.

SECTION 43. Allows DOER to access funds in the DOER Credit Trust Fund without requiring legislative appropriation.

SECTION 44. Provides for streamlined contracting processes for state agencies, building authorities and local government bodies who want to enter into contracts with electric or gas utilities for energy conservation projects with a total cost of less than $100,000.

SECTION 45. Technical change.

SECTION 46. Technical change.

SECTION 47. Technical change.

SECTION 48. Adds the Secretary of Energy and Environmental Affairs to the MTC board of directors.

SECTION 49. Establishes the Renewable Energy Trust Fund within the Massachusetts Technology Park Corporation and creates a 9 member governing board which includes the commissioner of energy resources (chair); the secretary of energy and environmental affairs or a designee; the secretary of housing and economic development or a designee; the secretary of administration and finance or a designee; 1 member of the board to be appointed by the chair of the board; and 4 members to be appointed by the governor. The governing board will have wide-ranging responsibilities for developing strategic plans and the disbursement of funds.

SECTION 50. Extends the authorized payback period for local debt related to energy conservation and renewable and alternative energy projects from 10 to 20 years.

SECTION 51. Definitions relating to alternative fueled vehicles.

SECTION 52. Definitions relating to alternative fueled vehicles.

SECTION 53. Definition relating to efficiency of hybrid vehicles.

SECTION 54. Requires building inspectors to have knowledge of energy code requirements.

SECTION 55. ***Building Energy Codes***: the bill requires the Board of Building Regulations and Standards (BBRS) to adopt the latest edition of the IECC energy code, and to update its code within 1 year of any IECC revision. In addition, the BBRS must develop regulations (1) to require all new construction and major renovations comply with the energy conservation code, (2) to certify and train energy inspectors, (3) to require energy performance commissioning for all new and renovated large, non-residential buildings.

SECTION 56. Delineates regulatory authority of common carriers among DPU and Dept. of Telecommunications and Cable.

SECTION 57. Definitions relating to manufacture and sale of gas and electricity.

SECTION 58. Expressly allows electric companies and distribution companies from building, owning, and operating solar energy facilities. Cap is 25 MW before January 1, 2009 and 50 MW after January 1, 2010.

SECTION 59. Repeals SECTION 58 (note repeal effective date of 2012 in SECTION 122).

SECTION 60. Requires utilities to provide information about competitive supply options.

SECTION 61. Increases maximum penalty for utility failure to meet service quality standards from 2% to 2.5%.

SECTION 62. Technical change.

SECTION 63. Deletes DPU requirement to investigate low-income discount rates.

SECTION 64. Provides for low-income discount rates for eligible residential consumers.

SECTION 65. Technical change.

SECTION 66. Clarification that municipal light plant activities shall not be considered energy brokering of individual members.

SECTION 67. Adds steam distribution companies to the list of utilities who are responsible for the administration of an underground plant damage prevention system.

SECTION 68. Adds steam distribution companies to the list of utilities who are responsible for the administration of an underground plant damage prevention system.

SECTION 69. Excludes steam distribution companies from being authorized to consolidate, merge, or sell or convey properties.

SECTION 70. Authorizes municipal light plant company personnel to inspect meters on private premises.

SECTION 71. Clarifies company rights to meter inspection.

SECTION 72. Clarifies company rights to meter inspection.

SECTION 73. Clarifies company rights to meter inspection.

SECTION 74. Technical change.

SECTION 75. Streamlines the DPU approval process for municipal aggregation plans.

SECTION 76. Technical change.

SECTION 77. Technical change.

SECTION 78. ***Net Metering***: establishes provisions around net metering, the aggregate capacity of net metering shall not exceed 1 per cent of the distribution company's peak load. The department will continue to remove any impediments to the development of efficient, low-emissions distributed generation.

SECTION 79. Establishes DPU oversight and regulation of steam distribution companies.

SECTION 80. Technical change.

SECTION 81. Technical change.

SECTION 82. Technical change.

SECTION 83. ***Long Term Renewable Contracting:*** as part of a 5 year pilot program, utilities are mandated to enter into long term contracts of 10-15 years in length for up to 3% of their total load to spur construction and financing of new renewables. Utilities will receive compensation of 4% of the annual contract payments for accepting the financial obligation of the long-term contract.

SECTION 84. Establishes an "energy pay and save" pilot program (50-200 participants) within EOEEA that promotes on-bill financing of energy efficiency or renewable energy products.

SECTION 85. Requires each electric utility to propose smart grid pilot program, with the objective to reduce peak and average loads by a minimum of 5 per cent.

SECTION 86. Requires the DPU to direct all distribution companies to submit plans to provide retail access to competitive sellers of renewable energy attributes.

SECTION 87. Establishes a special commission to study the burning of construction and demolition waste as it relates to the RPS. The commission's recommendations are due July 1, 2009.

SECTION 88. Establishes a green building commission to examine the economic and environmental impacts of establishing a green building plan for the state. The commission's report is due December 31, 2009.

SECTION 89. Establishes a commission to study the siting of energy facilities in the state, which must report its findings 18 months after the effective date of the act.

SECTION 90. Establishes a DOER pilot program to assist residential consumers with the purchase of energy efficient products through zero and low interest loans.

SECTION 91. Requires the DPU to file a report by January 1, 2011 on the effectiveness of the all cost-effective efficiency mandate.

SECTION 92. Requires DPU hearings on the maintenance and improvements of gas utility gate boxes.

SECTION 93. Dedicates RPS alternative compliance payments to the following purposes: (1) green communities; (2) state or community colleges engaged in renewable or other energy projects; (3) in-state flywheel companies; (4) capital investments in generating units that burn Massachusetts manufactured paper cubes.

SECTION 94. Requires the DPU to review and assess the effects of allowing utilities to build and own solar generation facilities, and to report to the legislature by June 30, 2011.

SECTION 95. Exempts existing mergers or consolidations of holding companies from MGL 164 § 96.

SECTION 96. Requires that DCAM establish a methodology for assessing life-cycle costs for all state agencies.

SECTION 97. Requires the energy advisory council to commission a cost-effectiveness study of energy efficiency and demand response programs. The report is due December 31, 2009.

SECTION 98. Requires DPU to set rules under which non-utility competitive suppliers can be included in retail billing programs.

SECTION 99. Requires the Mass. Turnpike Authority to develop a plan for providing alternative fueling terminals at all turnpike fueling facilities by January 2014.

SECTION 100. Requires DOER to develop a master plan for the advancement of hybrid and alternative fueled vehicles. The plan is due to the legislature within 18 months of the bill's passage.

SECTION 101. Requires the operational services division to develop a plan for facilitating bulk purchases of alternative fuels.

SECTION 102. Requires DPU to hold a public hearing to examine the impacts of competitive retail electricity marketplace through the default service mechanism.

SECTION 103. Requires utilities to file plan for compliance with billing requirements.

SECTION 104. First Green Communities reporting deadline will be April 1, 2020.

SECTION 105. Sets RPS eligibility requirements for renewable energy imported from outside the ISO-NE region. The generating source must be a "committed capacity resource" and will only receive RPS credit for renewable energy actually generated and delivered. Any RPS credits shall be reduced by any exports made by the generator from the ISO-NE region. DOER will develop regulations and will assess the feasibility of the import standards.

SECTION 106. Requires Dept. of Housing and Community Development to make recommendations on the use of state funds for LIHEAP.

SECTION 107. Requires DOER to study the viability of municipal-owned electric utilities.

SECTION 108. Requires DOER and UMASS to create a community educational pilot program to provide education on the economic benefits of energy efficiency and demand response.

SECTION 109. Requires DPU to open an investigation of *ex parte* communications.

SECTION 110. Prohibits the reduction of amounts or percentages of funding for low-income efficiency programs below January 1, 2008 status quo.

SECTION 111. Requires utilities to file their first efficiency plans with the energy efficiency advisory council on April 30, 2009. The utilities and council must file the plan and any comments with the DPU on October 31, 2009.

SECTION 112. Requires DEP to adopt regulations implementing RGGI provisions by March 1, 2009.

SECTION 113. Clarifies that RGGI section of this bill does not affect any multiyear RGGI agreements.

SECTION 114. Limits RGGI payments to host communities to tax years beginning on January 1, 2009 and expires on December 31, 2011.

SECTION 115. Allows DEP to withhold RGGI allowances (vintage 2009-2012) from auction to transition from 310 CMR 7.29 to RGGI.

SECTION 116. Sets state renewable, alternative and energy efficiency goals: (1) meet at least 25 per cent of the commonwealth's electric load by the year 2020 with demand side resources; (2) meet at least 20 per cent of the commonwealth's electric load by the year 2020 through new, renewable and alternative energy generation; (3) reduce the use of fossil fuel in buildings by 10 per cent from 2007 levels by the year 2020 through the increased efficiency of both equipment and the building envelope; (4) develop a plan to reduce total energy consumption in the commonwealth by at least 10 per cent by 2017 through the development and implementation of the green communities program.

Requires EOEEA to prepare a 5 year plan to meet the energy efficiency and renewable/alternative energy goals.

SECTION 117. RGGI section takes effect on July 1, 2008.

SECTION 118. RPS changes take effect on January 1, 2009.

SECTION 119. AEPS takes effect on January 1, 2009.

SECTION 120. IECC mandate takes effect 6 months after passage.

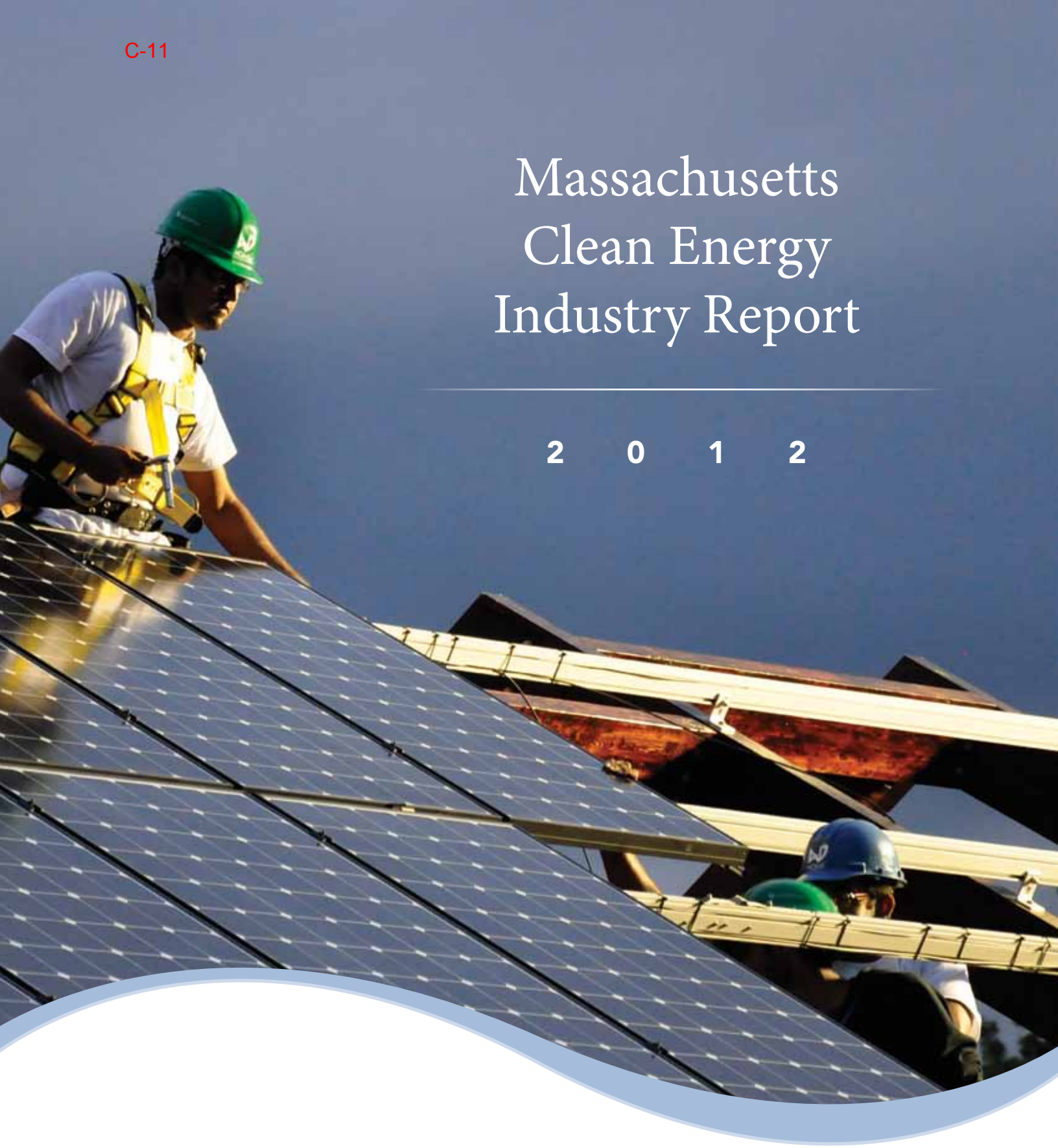
SECTION 121. Home energy audit information takes effect 1 year after passage.

SECTION 122. Repeal of utility owned solar generation (Section 59) takes effect June 30, 2012.

SECTION 123. Hybrid efficiency increase from 10% to 25% (Section 53) takes effect 3 years after passage.

SECTION 124. Technical change (Section 80) takes effect April 10, 2007.

C-11



Massachusetts Clean Energy Industry Report

2012

MASSACHUSETTS CLEAN ENERGY CENTER

[bw] RESEARCH PARTNERSHIP

Prepared for the Massachusetts Clean Energy Center
by BW Research Partnership

Cover photo by Julie Chen.

Table of Contents

Letter from MassCEC Board Chairman and Massachusetts Energy and Environmental Affairs (EEA) Secretary Rick Sullivan

Welcome to the 2012 Massachusetts Clean Energy Industry Report. This report follows our 2011 groundbreaking study to gauge the size and growth of clean energy sector employment and businesses. We are pleased to inform you that the industry grew significantly over the past 12 months and expects even stronger growth in the year to come.

Massachusetts is winning awards for our strong policies supporting energy efficiency and renewable energy. Fertile ground for these policies was laid when the Massachusetts legislature passed and Governor Patrick signed the Green Jobs Act creating the Massachusetts Clean Energy Center (MassCEC) in 2008.

MassCEC is dedicated to increasing the pace of clean energy growth, as the first state entity in the nation created with clean energy economic development as our primary goal. We are proud that Massachusetts is a recognized clean energy leader that can accelerate the development and commercialization of new technologies with world-class researchers, dedicated entrepreneurs, experienced investors and strong policies. To build on this success, we are assisting clean energy companies to harness these assets, increase the pace of project development, and access a pool of highly-qualified, well-trained workers.

Despite a tough economic environment across the globe, the Commonwealth's clean energy industry is growing rapidly. Our survey shows that there are now 71,523 employees working in clean energy throughout the Commonwealth, up 11.2% from 2011. This growth outpaced the overall economy by almost a factor of ten. Clean energy continues to maintain its place as one of our Commonwealth's marquee industries with 1.7% of the total Massachusetts workforce.

The clean energy sector is emerging as a powerful economic industry in Massachusetts that will continue to generate thousands of jobs in the coming decades, and secure Massachusetts as a national and global leader in clean energy. This report captures the full extent of the clean energy community that have joined the Commonwealth's clean energy revolution.

Rick Sullivan
MassCEC Board Chairman
EEA Secretary

Acknowledgements

The 2012 Massachusetts Clean Energy Industry Report is the result of an extensive research process involving over 1,000 respondents. Again, this year, MassCEC sincerely thanks all of the respondents for engaging with us to gather this important data. This information depends on their willingness to generously share their time and insights.

Research Team

The publication of this report would not have been possible without the hard work and dedication of the research team including:

- Phillip Jordan, BW Research
- Jamie Barrah, BW Research
- Veronica Williams, BW Research
- Josh Williams, BW Research

MassCEC Staff

- Martha Broad
- James Bowen
- Tamika Correia
- Sally Griffith
- Arthur Natella

In addition, MassCEC thanks Kevin Doyle for his Massachusetts workforce outreach efforts and would also like to acknowledge the industry associations that made a concerted effort to encourage their members to respond to the survey: Environmental Business Council of New England; Marine Renewable Energy Center (MREC); Massachusetts Association for Community Action (MassCAP); Mass Hydrogen Coalition; Massachusetts Manufacturing Extension Partnership (MassMEP); National Association of Energy Services Companies; New England Carpenters Regional Council; New England Clean Energy Council; New England Geothermal Professional Association (NEGPA); New Fuels Alliance; Northeast Energy Efficiency Council; Northeast Sustainable Energy Association (NESEA); and Solar Energy Business Association of New England (SEBANE).

Introduction

Massachusetts is a hotbed of innovation and invention. From computers to life sciences to defense, the Commonwealth has been at the forefront of new, exciting technologies for decades. With a robust ecosystem including world-class universities, abundant venture capital, a large professional services industry, and a deep and talented labor pool, Massachusetts has emerged as a leader in clean energy development and integration.

The Commonwealth ranks second in the nation for private clean energy investment (and first on a per-capita basis), and Massachusetts-based companies have received 17%—or $62.8 million—of the federal dollars awarded through the U.S. Department of Energy's ARPA-E program, which is devoted to advanced energy research projects that are transformational, sustainable, and bridge the gap between basic energy research and developmental and industrial innovation. At the same time, the Bay State has significantly increased its production of renewable energy, with a thirty-fold increase in installed solar megawatts and a 108% growth in electric energy savings from energy efficiency between 2007 and 2011. The clean energy industry creates jobs throughout the state and keeps the Massachusetts innovation engine running.

Market demand for clean energy products continues to increase. In 2011, the Massachusetts Clean Energy Center (MassCEC) released a groundbreaking report as part of its requirement to conduct an annual accounting of the clean energy industry in Massachusetts. The report demonstrated that due to a mix of leading academic institutions; an active network of technologists, entrepreneurs, and investors; a highly skilled workforce; market-building public policy; and engaged government leaders, Massachusetts was well positioned to take advantage of growing demand. The report also found that the Commonwealth is home to a large and diverse clean energy economy. Specifically, the 2011 report found 4,908 clean energy firms in Massa-

chusetts employing 64,310 clean energy workers, or 1.5% of all employees in the Commonwealth. These jobs are found in every county in Massachusetts, across activities ranging from engineering and research to manufacturing, and across industry sectors ranging from renewable energy to energy efficiency. And employers reported strong growth; at 6.7% growth from 2010, the report showed that clean energy firms were adding employees at a rate more than six times higher than in the economy overall.

This 2012 report provides updated information regarding many of the findings in the 2011 report. As with the 2011 report, this 2012 report is based on survey data gathered directly from clean energy employers that have been identified across a wide variety of industries in the Commonwealth. This differentiates the report from other studies, which typically rely solely on databases of known employers—those organizations that are members of industry associations, have signed up for various clean energy incentives or programs, or have been otherwise identified as conducting clean energy work. Though these known-employer lists are important in researching the clean energy economy, analyses based solely on such lists can undercount clean energy workers because they miss the large number of companies engaged in clean energy work that have not yet been identified as part of the cluster. Furthermore, most clean energy employment studies tend to rely on assumptions and economic models, or are based on incomplete or unverified employment counts from secondary sources. These sources cannot capture in-depth employer information because employers are not active participants in the research.

In order to obtain a more complete picture of clean energy employers, the team conducted a survey of randomly selected Commonwealth employers from industries identified as being potentially related to clean energy. To capture the breadth of the cluster, surveys were administered online and by telephone to a list of known clean energy employers as well as to a representative, clustered sample of companies across the entire Commonwealth. This sample included companies from all across the value chain, from manufacturing to service and from research and development to construction. This same method of employer identification was used for the 2011 report, allowing us to effectively compare data from both years.

The findings in this report are highly reliable because they come straight from the source: the clean energy employers of Massachusetts. Further, the research refines and validates the findings of 2011. Over the past two years, the research team attempted approximately 45,000 telephone calls and sent over 10,000 emails to employers. This massive survey effort, with

KEY FINDINGS OF THE 2012 MA CLEAN ENERGY INDUSTRY STUDY

- **4,995** *clean energy firms*
- **71,523** *clean energy workers*
- **1.7%** *of total workers in the Commonwealth*
- **11.2%** *employment growth rate from 2011 to 2012*

a combined margin of error of approximately +/-3.1% at a 95% confidence interval, yielded 930 survey responses.

As a result of this intensive research effort, the *2012 Massachusetts Clean Energy Industry Report* provides comprehensive and reliable data on the number of clean energy firms and employees while validating the findings from 2011. This report finds that Massachusetts has a large clean energy cluster with 4,955 clean energy firms that employ 71,523 clean energy workers. For the purpose of this report, a clean energy firm is defined as an employer engaged in whole or in part in providing goods and services related to renewable energy, energy efficiency, alternative transportation, and carbon management. Clean energy workers are defined as spending at least a portion of their time supporting the clean energy aspects of their businesses.

In addition to the overall numbers, there are several important findings from this research. First, the 71,523 clean energy workers in Massachusetts represent 1.7% of total employment in the Commonwealth, an increase from last year and a number large enough to warrant considering the clean energy cluster a key sector in Massachusetts. Though there are many reasons for the cluster's strength, one factor is that the cluster has breadth and depth across multiple industries and technology areas. Despite uneven performance within value chain activities, the breadth allows for the cluster's continued growth and strength in the Commonwealth.

The research also finds that Massachusetts clean energy employers are growing significantly faster than their peers in other sectors. Since 2011, clean energy employment has grown by 11.2%, nearly 10 times faster than the overall 1.2% growth rate[1] among all industries in the Commonwealth over the same period. The 11.2% employment growth rate shows that the pace is in fact quickening, outpacing the same period from 2010-2011 by more than 3,000 jobs. Employers are also optimistic about their future prospects, anticipating 12.4% growth over the coming 12 months.

The following pages include detailed findings of the research, including a review of the size, growth, distribution, and workforce needs of clean energy employers in Massachusetts.

1 EMSI Complete Employment, 2012.1.

Research Findings

Clean Energy is a Large Industry Cluster in Massachusetts

As reported in 2011, the passage of key legislative and policy initiatives, including the Green Communities Act, the Green Jobs Act, and the Global Warming Solutions Act,[2] have paid off by producing a large and growing cluster of companies. These initiatives, together with expanded incentive and training programs, have "cemented the state's position as a national leader in smart, proactive policies promoting clean-energy development."[3]

Investments in clean energy have clearly produced dividends. Massachusetts is currently home to 4,995 clean energy employers and 71,523 clean energy workers.

Clean energy workers make up 1.7% of all workers in the Commonwealth and are found in numerous industries across the state. Of these 71,523 workers, 18,280 work primarily with installation and maintenance firms; 20,671 work in sales and distribution; 13,182 work for engineering and research firms; 11,162 work for manufacturers, and 8,229 work for other types of clean energy companies, such as legal, finance, and policy firms.

Clean energy firms work in many technology areas, led by energy efficiency and renewable energy. Specifically, 2,646 firms and 40,207 clean energy workers produce goods or services related to energy efficiency, while 2,205 firms and 29,777 clean energy workers work with renewable energy.[4]

2 "A Future of Clean Energy and Growth: Advancing Massachusetts' Clean Energy Leadership," CleanEdge, April 2010.

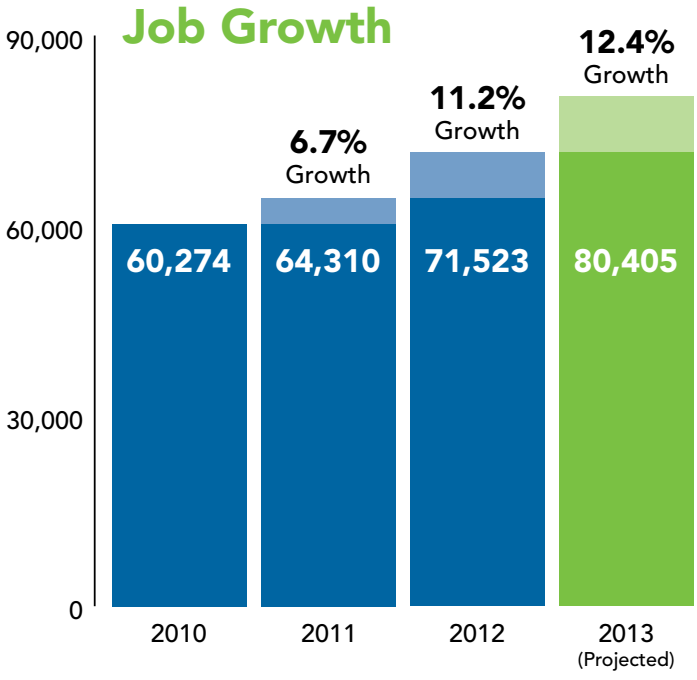
3 *Id.*

4 Note that this includes overlap. Many of the firms reported work with both renewable energy and energy efficiency technologies.

The size of the cluster is impressive, demonstrating Massachusetts' position as a national leader in clean energy. Given the Commonwealth's strong employer base, leading policies, and clear commitment to growing the cluster, the potential for employment growth in the clean energy sector is significant.

Clean Energy Employers in Massachusetts are Growing Rapidly

Overall, clean energy firms in Massachusetts have experienced impressive growth from July 2011 to June 2012, adding 7,213 new jobs—an 11.2% growth rate. Despite job growth of 1.2% for all Massachusetts jobs over the period,[5] nearly one-third of all clean energy companies grew, while only 13% cut their workforce. This finding highlights clean energy as a bright spot in jobs recovery in the Bay State.



The research also found that respondents are optimistic about future growth. Overall, clean energy employers expect to have 8,881 more clean energy jobs over the coming 12 months, a 12.4% growth rate in clean energy employment. Thirty-eight percent of employers expect to have more clean energy workers in the coming year, while only 2.7% expect fewer. In comparison, overall Massachusetts employment is projected to grow by 1.4% over the coming 12 months.[6]

Clean Energy is Generating Jobs and Creating New Businesses

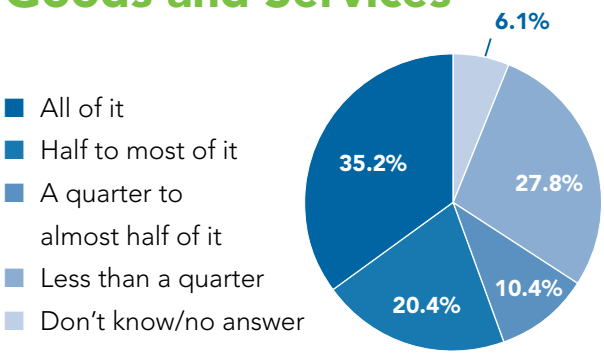
The 11.2% growth from 2012 is a combination of new positions at existing clean energy firms, repurposing of employees to support clean energy at existing firms, and new businesses. Of the new clean energy workers added over the last year, nearly three-quarters were reported as having been hired to new positions, while 26% were in existing positions to which clean energy responsibilities were added.

5 EMSI Complete Employment, 2012.1.
6 *Id.*

Clean Energy is Generating an Increasing Share of Revenue

Businesses report that their clean energy revenues are increasing as a share of overall revenue. Thirty-five percent of surveyed firms reported that 100% of their revenues are attributed to clean energy goods and services, while 56% receive at least half of their revenue from clean energy work. This work is defined as producing goods or services related to renewable energy, energy efficiency, carbon management, or alternative transportation.

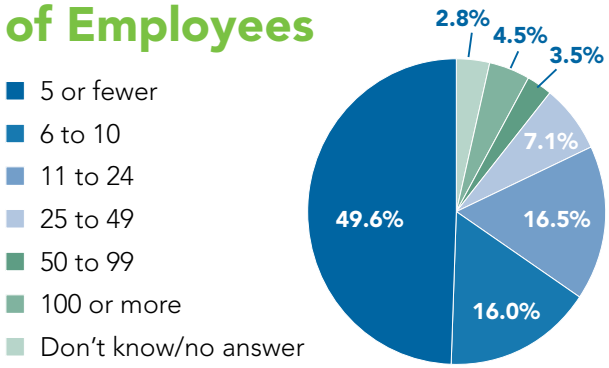
Percent of Revenue From Clean Energy Goods and Services



Small Businesses Continue to Play a Key Role in the Clean Energy Cluster

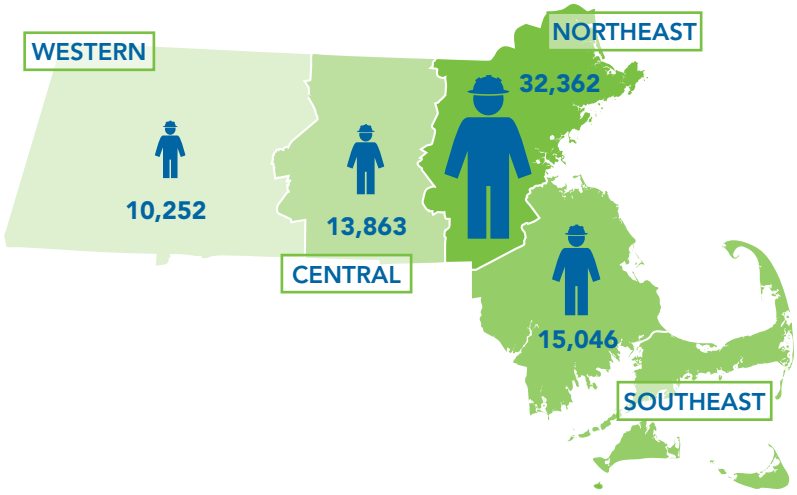
The majority of the Commonwealth's clean energy employers are small, with nearly two-thirds having ten or fewer permanent clean energy employees.

Company Size by Number of Employees



Clean Energy Firms are Distributed Throughout the Commonwealth, but Growth is Uneven

Clean energy employment can be found throughout the Bay State. The map below illustrates the clean energy employment concentrations of the four Green Community Regions in Massachusetts. The Northeast has the greatest concentration of workers, followed by the



Southeast, Central, and West. All areas, however, show significant employment, ranging from 10,252 clean energy workers in the West to 32,362 clean energy workers in the Northeast.

Despite solid gains last year, clean energy employment in the Southeast region actually declined by 252 workers, or 1.6%. These losses were offset by growth in the Northeast and Central regions at 17.5% and 17.4% employment growth, respectively. The West also grew by 6.2%, adding nearly 600 clean energy workers. Clean energy employers expect to grow their clean energy employment by 19.4% in the Southeast, 13% in the Northeast, 6.2% in the Central, and 8.6% in the West.

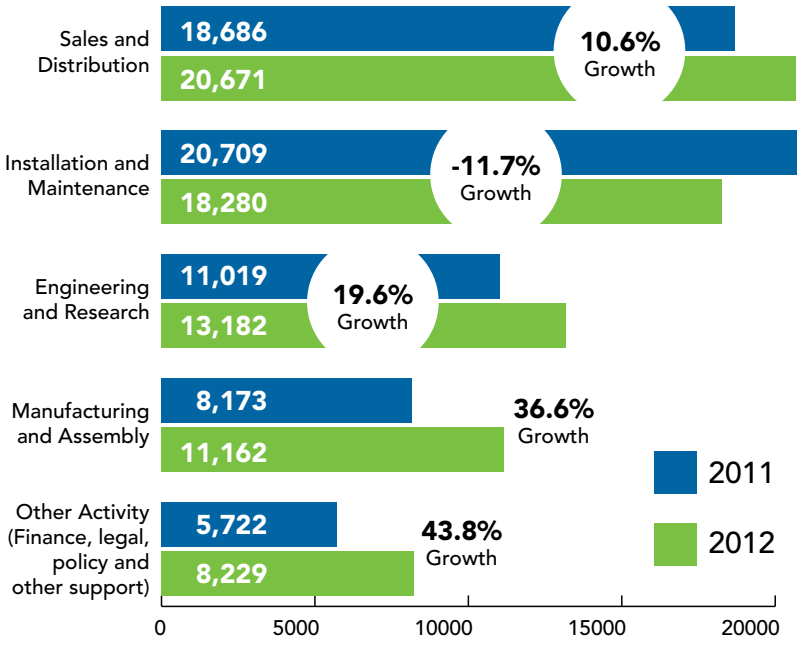
Clean Energy is Generating Growth in Numerous Industries in Massachusetts

In addition to the impressive size of the cluster, the research shows that its diverse activities are bolstering growth. Though specific industry segments such as R&D, professional services, and sales are clearly important to the cluster, the entire value chain of activities is well represented in Massachusetts, as illustrated by Table 1 below.

Table 1: Current Clean Energy Employment, Overall[7]

Primary Value Chain Activity	2012 Establishment Count	2012 Employment Count	2011-2012 Employment Growth Rate	Percentage of Total, by Establishment	Percentage of Total, by Employment
Manufacturing and Assembly	489	11,162	37%	10%	16%
Engineering and Research	889	13,182	20%	18%	18%
Sales and Distribution	917	20,671	11%	18%	29%
Installation and Maintenance	1,996	18,280	-12%	40%	26%
Other Activity (Finance, legal, policy, and other support)	705	8,229	44%	14%	12%
Total	**4,995**	**71,523**	**11%**		

7 Note that the total in each category is rounded to the nearest worker, which explains the difference with the totals reported herein.



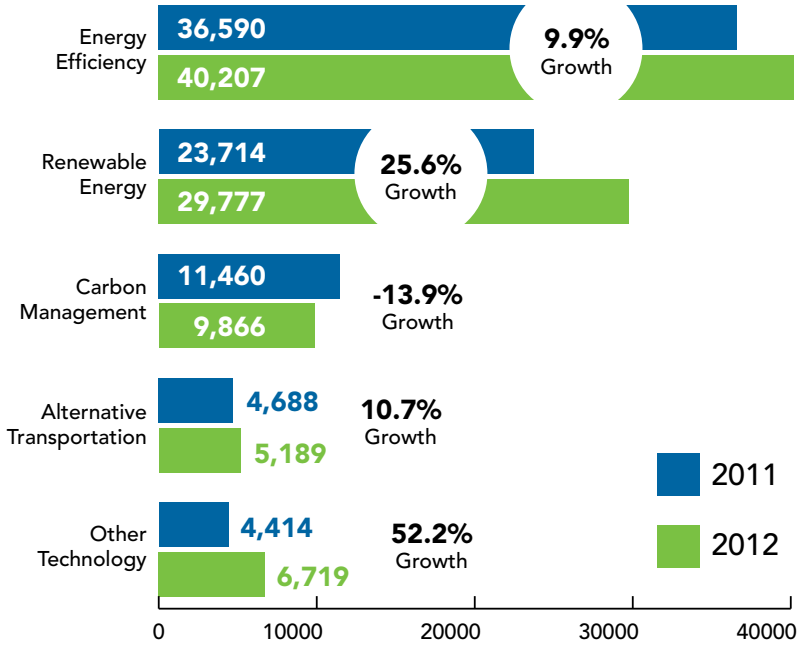
There are many firms engaged in more than one activity, **installation and maintenance is the largest value chain activity by number of firms, while sales and distribution firms employ the most clean energy workers.** More than one in three clean energy firms in Massachusetts is primarily engaged in installation and maintenance, while nearly one in five is an engineering or R&D firm. Sales and distribution and manufacturing are also clearly important segments of the cluster, making up 14% and 10% respectively.

Challenges in the Construction Sector are Impacting Installation and Maintenance Firms

The only segment of the clean energy economy that is experiencing a decline in employment is installation and maintenance, and the decline is significant at 12%. This decline reflects continued weakness in the construction sector in the Commonwealth, as there are fewer construction firms and fewer workers at those that remain. Additionally, increased efficiency and consolidation of firms has impacted overall employment in this area. Despite these negatives, the mere fact that the industry grew by 11.2% despite a steep decline in its largest segment shows just how diverse and strong the cluster is in the Bay State.

Multiple Technology Areas are Growing

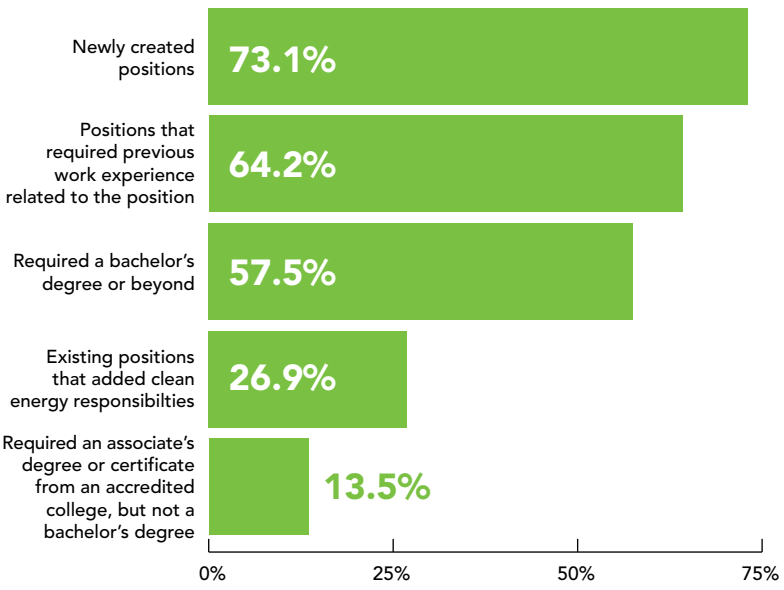
The research shows that clean energy firms in Massachusetts are working across a spectrum of technology areas, and in many cases in more than one. Survey participants were first asked to list the major technology areas with



Business Type	2012 Establishment Count	2012 Employment Count	2011-2012 Employment Growth Rate
Renewable Energy	2,205	29,777	26%
Energy Efficiency	2,646	40,207	10%
Alternative Transportation	403	5,189	11%
Carbon Management	437	9,866	-14%
Other Technology	723	6,719	52%

which their employers are most closely associated. Because researchers anticipated that many employers would be active in a number of technology areas, multiple responses were permitted.

Renewable energy is adding the most jobs, with an impressive 26% growth rate since 2011. Energy efficiency is also adding many jobs, as are "other firms" where most of the professional services firms are located. Carbon management is smaller than reported in 2011, primarily because many firms that classified themselves as engaged in carbon management in 2011 were actually energy efficiency or "other" firms.



Massachusetts Clean Energy Firms Seek Educated, Experienced Workers

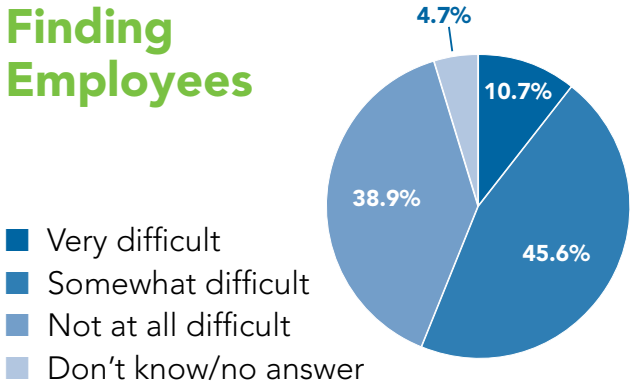
Massachusetts clean energy employers were asked targeted questions about their new clean energy workers in an attempt to understand the types of applicants that are achieving successful employment outcomes. The 2011 study demonstrated that Massachusetts employers value educational credentials, expecting higher levels of education than their counterparts in other regions of the country. The 2012 research underscores this finding, with employers reporting that 58% of new clean energy hires were required to have a bachelor's degree or beyond, and another 14% were required to have an associate's degree or certificate.

At the same time, employers are seeking experienced workers, reporting that 64% of the new clean energy positions required previous work experience related to the job.

Of the newly created positions, the largest segment deals with technical work, such as technicians and production workers. Management and professional positions are the second largest segment, followed by administrative positions and sales positions.

C-25

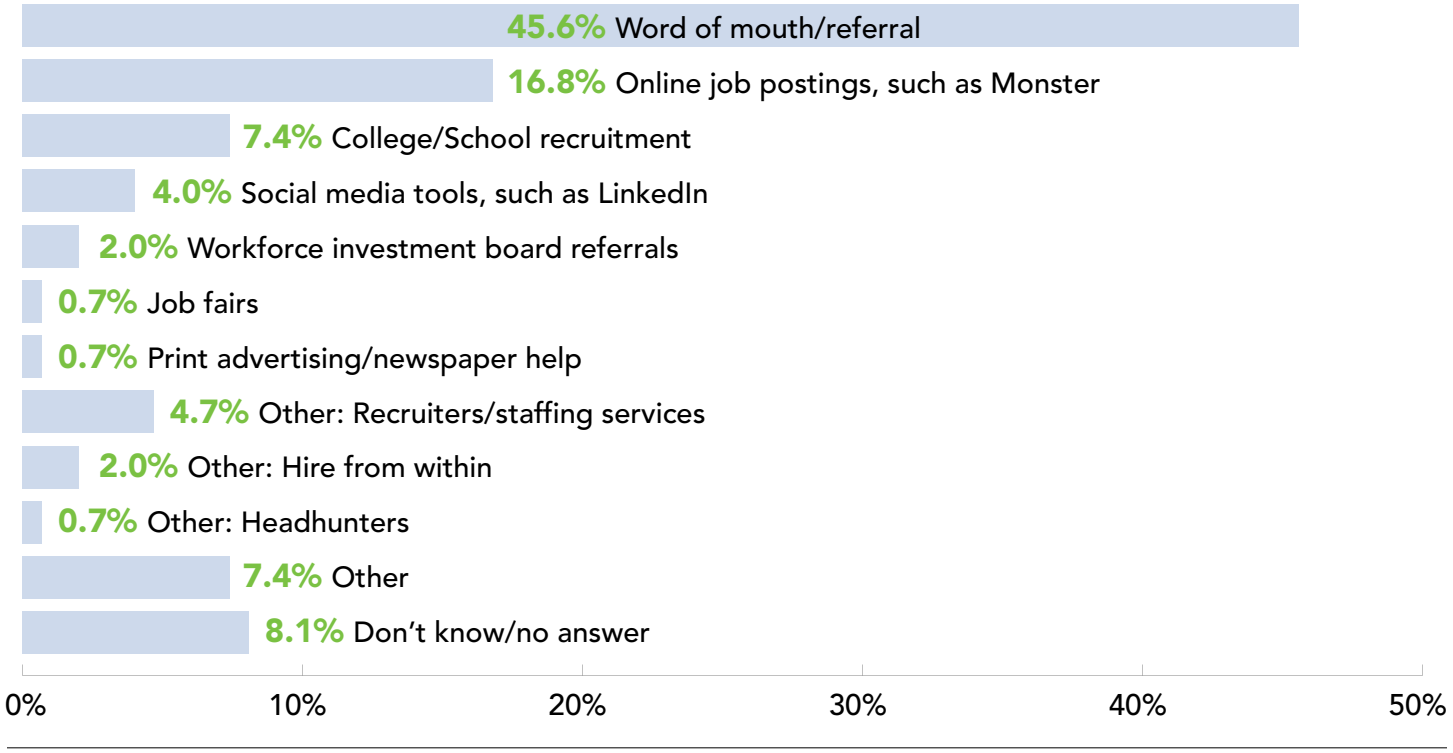
Finding Employees



Despite solid growth in the industry, nearly 85% of clean energy employers in Massachusetts report some or no difficulty finding adequately prepared workers, with only 11% reporting great difficulty. Employers reported that the greatest deficiencies of applicants include lack of required technical skills, lack of required education, and poor communication, problem solving, and analytical skills.

More than two-thirds of all firms that added workers over the past year use word of mouth and referrals, while about one-third reported posting the position online using a job board. About one-quarter of firms recruit directly out of colleges and schools, and a growing number (16%) are using social media to recruit new employees.

When asked which method has been most successful for finding qualified applicants, 46% reported that word of mouth referrals were most successful, while online job boards were cited only 17% of the time, and college recruiting was cited by 7.4% of employers.[8]



8 Note that these questions were not asked of all employers, only those that added employees over the past 12 months.

Conclusions

Clean energy continues to be a shining example of Massachusetts's innovation economy, and this report underscores its importance to the Bay State. The Massachusetts clean energy cluster is growing at a rapid clip of 11.2%, outpacing the overall economy nearly tenfold. The 4,995 clean energy firms and 71,523 clean energy jobs in the Commonwealth are responsible for 1.7% of all employment in the state. The cluster shows no signs of slowing, either, with employers anticipating 12.4% growth over the next 12 months. Such impressive growth certainly cements the cluster's place as a marquee industry in the Commonwealth.

With only a few exceptions, this growth is spread evenly throughout the Bay State, creating jobs in manufacturing, engineering, sales, and professional services. The Commonwealth's successes in the areas of renewable energy and energy efficiency technologies highlight a strong and vibrant ecosystem of firms.

There are a few areas of concern. Despite dramatic growth among most of the value chain activities, Massachusetts installation and maintenance firms report declining employment. Though the research suggests that this is mostly due to overall weakness in the construction industry, the Commonwealth should do more to spur residential and commercial installations of clean energy goods and services. Given the research findings, targeted help for small businesses will also pay dividends in this important cluster.

Continued commitment to education is clearly critical to maintaining a thriving clean energy cluster in the Commonwealth. Employers in Massachusetts require more education than their counterparts in other states, and the importance of a college degree is in evidence. Though Massachusetts ranks first in the nation for college degree attainment, more should be done to teach students about STEM fields and clean energy careers at the K-12 level, increase access to college, expand clean energy baccalaureate programs at public universities, and develop targeted policies to maintain the Commonwealth's high standard of living in order to ensure that the state is able to continue developing skilled workers and retaining them after graduation.

Massachusetts has long been a hub of technological innovation. By continuing to support this growing cluster, the Commonwealth can build upon this success well into the 21st century.

Appendix A: Research Methodology

In June and July of 2011 and May and June of 2012, BW Research worked closely with the Massachusetts Clean Energy Center to conduct a survey of clean energy companies in the Commonwealth. For the purposes of the survey, a clean energy firm is defined as a company involved with an activity related to the clean energy industry. The Clean Energy Industry is defined as being directly involved with researching, developing, producing, manufacturing, distributing or implementing components, goods or services related to renewable energy, energy efficiency or conservation, smart grid, energy storage, carbon management, and/or electric or hybrid vehicles. Clean energy employees are defined as full-time and part-time permanent employees who support the clean energy portion of the business, including administrative staff.

In order to accurately capture data from the cluster, surveys were administered online and by telephone to a list of known employers as well as to a representative, clustered sample of companies from the NAICS industries identified by the Bureau of Labor Statistics as being potentially related to the renewable energy, energy efficiency, and alternative transportation sectors.

Over the two years of surveying, the research team attempted approximately 45,000 telephone calls and sent over 10,000 emails to employers. The survey effort, with a combined margin of error of approximately +/-3.1% at a 95% confidence interval, yielded 1,401 survey responses from the samples in 2011 and 930 responses in 2012. The 2011 survey fielded from June 30 to July 29, 2011 and averaged 15 minutes in length and the 2012 survey fielded from May 8 to June 1 and averaged 10 minutes in length.

Known Universe

The original list, developed from previous work efforts and databases from the Massachusetts Clean Energy Center and partner organizations, contains the companies that are more likely to be active in the clean energy economy. After duplicate cleaning and applying estimates from the survey data to account for companies that are no longer in business, do not have at least one Massachusetts location, or do not identify as in the clean energy industry, as well as improvements and additions since the first survey effort, the 2012 known universe of firms is estimated at 1,599 companies.

All firms in the database with email information were sent multiple online invitations.

Firms in the database that did not complete an online survey and those without email information were called up to six times and asked to complete the telephone version.

Of the estimated 1,599 firms in the known universe, 445 completed a survey (28%). These employers have a mean of 21.36 clean energy workers per clean energy firm in the known database. Therefore, the higher mean and increased universe in 2012 yield 34,170 workers in the known universe, an increase of 35.7%. Due to the high participation rate, the margin of error is low at a confidence level of 95% (approximately +/- 3.9%).

Unknown Universe

This database for the unknown universe was drawn from BLS NAICS industries and InfoUSA company listings. The list contains 16,783 firms, which were clustered by industry (agriculture, manufacturing, sales/trade, services/R&D, construction, and repair) and by size (small, medium, large). Firms were randomly called within the clusters and the known firms were removed from the sample. In total, calls were made to 4,255 of the 16,783 firms in the 2012 database and up to four attempts were made per firm, in order to determine whether there were significant differences in the incidence and churn rates between 2011 and 2012.

There were no statistically significance differences in the incidence rates (i.e., the percentage of firms that identified as clean energy) for any of the 18 clusters. As such and because the 2011 sampling was more comprehensive (calls were made to 16,237 of the 17,245 firms in the database as part of the 2011 project), the rates for 2011 were carried over to 2012. Statistically higher churn rates (i.e., the percentage of firms no longer in business, disconnected or wrong number, etc.) were found in four of the 18 clusters and were applied to 2012.

In addition, 171 firms from the unknown universe identified as clean energy and completed full surveys. Due to the more robust and representative survey effort undertaken in 2011, the data utilized for extrapolations for the unknown universe (with the exception of the future growth statistic) were carried over from 2011 (e.g., average clean energy employment, percent breakdown by technology area, value chain activity, and geography).

Compared to the known universe, the level of clean energy employment at "unknown" firms is lower by a significant margin, with a mean of 11 (compared to 21.36 in the known sample), and the overall number of clean energy firms in the unknown universe is declining, resulting in a decline of 4.6% in employment to 37,353.

MASSACHUSETTS CLEAN ENERGY CENTER

55 Summer Street, 9th Floor Boston, MA 02110

Phone: 617-315-9355 | Fax: 617-315-9356

Info@masscec.com | www.masscec.com

THE 2011 STATE ENERGY EFFICIENCY SCORECARD

Michael Sciortino, Max Neubauer, Shruti Vaidyanathan, Anna Chittum,
Sara Hayes, Seth Nowak, and Maggie Molina

Contributing Authors: Colin Sheppard, Arne Jacobson, and Charles Chamberlin
(Schatz Energy Research Center, Humboldt State University),
and Yerina Mugica (Natural Resources Defense Council)

October 2011

Report Number E115

529 14th Street, N.W., Suite 600, Washington, D.C. 20045
(202) 507-4000 phone, (202) 429-2248 fax, aceee.org

CONTENTS

EXECUTIVE SUMMARY

Introduction

In 2011, energy efficiency continued to build momentum in the states despite a sluggish economic recovery, a partisan political climate, and the failure of Congress to develop a comprehensive energy policy. Governors, state legislators, regulators, and citizens are increasingly recognizing that energy efficiency—the kilowatt-hours and gallons of gasoline we *don't* use as a result of improved technologies and practices—is the cheapest, cleanest, and quickest energy resource to deploy. Indeed, energy efficiency is a key solution to our economic, energy, and environmental challenges. Fully harnessing America's untapped, abundant energy efficiency resource will not only save consumers and businesses money, but will also unleash technological innovation and new business opportunities that create and sustain jobs. As they have over the past decades, ***states continue to provide the leadership needed to forge an energy-efficient economy, which reduces energy costs, spurs job growth, and benefits the environment.***

In the fifth edition of ACEEE's *State Energy Efficiency Scorecard*, we present a comprehensive ranking of the states based on an array of metrics that capture best practices and recognize leadership in energy efficiency policy and program implementation. The *Scorecard* benchmarks progress and provides a roadmap for states to advance energy efficiency in the residential, commercial, industrial, and transportation sectors. A new, diverse set of states has followed a group of leading states by adopting significant energy efficiency policies, which will lead to innovative and effective programs. Nonetheless, the tremendous potential remaining for energy efficiency savings in all of the states should motivate decision-makers to advance energy efficiency. Cost-effective investment in energy efficiency now will be critical for the success of local, state, and national economies in the future.

Key Findings

- Facing uncertain economic times, states are continuing to use energy efficiency as a key strategy to generate cost-savings, promote technological innovation, and stimulate growth. Energy efficiency is also a pragmatic, bipartisan solution that political leaders from both sides of the aisle have supported over the past year.
- Earning the #1 ranking, Massachusetts has overtaken California, which had placed atop the rankings the last four years. Central to Massachusetts' success is the continued implementation of the 2008 Green Communities Act, which laid the foundation for greater investment in energy efficiency programs.
- This year's most improved states include Michigan, Illinois, Nebraska, Tennessee, Alabama, and Maryland. Michigan, Illinois, and Maryland have significantly increased utility-sector energy efficiency efforts in order to meet energy savings targets established in Energy Efficiency Resource Standards (EERS) passed in 2008. Illinois and Maryland also recently adopted energy-efficient transportation policies and Michigan has become a leader in the research and development of energy-efficient technologies. Tennessee, Nebraska, and Alabama saw improvements across categories, particularly in the adoption of stringent building codes.
- Not far behind Massachusetts and California, a group of states including New York, Vermont, Oregon, Washington, Connecticut, Minnesota, and Rhode Island remain in the top ten and continue to lead the nation in energy efficiency policy and program implementation across all economic sectors.
- Total budgets for electricity efficiency programs increased to $4.5 billion in 2010, up from $3.4 billion in 2009. Combined with natural gas program budgets of about $1 billion, total energy efficiency budgets in 2010 equal about 5.5 billion dollars (see Figure ES-2). Given the increasing regulatory commitments to energy efficiency, this growth will likely continue over the next decade.
- Twenty-four states have adopted Energy Efficiency Resource Standards, which set long-term energy savings targets and drives utility-sector investments in energy efficiency programs. States that adopted EERS policies in 2007 and 2008 are realizing significant energy savings and moving ahead in the *Scorecard* rankings.

- States continue to improve policies to reduce financial, technical, and regulatory barriers to adoption and deployment of combined heat and power (CHP) systems, which generate electricity and thermal energy in an integrated system. Tremendous potential remains for CHP, particularly in states with heavy industrial and manufacturing bases.
- Twenty-nine states have either adopted or have made significant progress toward the adoption of the latest energy-saving building codes for homes and commercial properties — up from twenty in 2010 and ten in 2009.
- A group of leading states remains ahead of the curve in adopting policies to reduce vehicle miles traveled and promote the purchase and manufacture of efficient vehicles. A major gap exists, however, as over half the states have minimal or no policies to encourage efficiency in the transportation sector.

Methodology

This report provides a comprehensive assessment of policy and programs that improve energy efficiency in our homes, businesses, industry, and transportation sectors. The *2011 Scorecard* examines six state energy efficiency policy areas and presents these results in six chapters (1) utility and public benefits programs and policies; (2) transportation policies; (3) building energy codes; (4) combined heat and power; (5) state government initiatives; and (6) appliance efficiency standards. States can earn up to 50 possible points in these six policy areas combined, with the maximum possible points in each area weighted by the magnitude of its potential energy savings impact.

The base year for policy assessment in the *2011 Scorecard* varies by the policy area examined. Most scores are based on policies and programs in place as of September 2011. In some cases, however, we can only score states using the most recent years for which data is available from all states. For example, Chapter 1 evaluates utility-sector energy efficiency based on policies in place as of September 2011, program budgets for 2010, and program energy savings performance in 2009.

To verify the accuracy and comprehensiveness of the policy information and data on which we score the states, we directly reached out to state-level stakeholders whose on-the-ground expertise is invaluable to the accuracy of our *Scorecard*. Officials at state energy offices and public utility commissions responded to initial policy and data requests, reviewed the draft report, and checked the material on the ACEEE State Energy Policy Database on our Web site, which houses more detailed policy references and information upon which we score the states.[1] Regional nonprofits and national organizations also contributed to the review process.

Summary of Rankings

Figure ES-1 shows the results of the state *Scorecard* rankings and classifies the states and the District of Columbia into five bins according to their ranks. Table ES-1 shows scores for each of the six policy areas, overall rankings, total scores out of a maximum possible 50 points, and change in a state's rank compared to last year's report.

The top ten states this year, shown in Table ES-2, score at least 29.5 points out of the possible 50 points, with California and Massachusetts taking the top two spots with 45.5 and 44 points, respectively. The next tier of ten states follows closely behind, scoring between 24.5 and 27 points. The third tier of states scores at least 18.5 points and the fourth tier scores more than 10 points, while states in the lowest tier score 10 points or less.

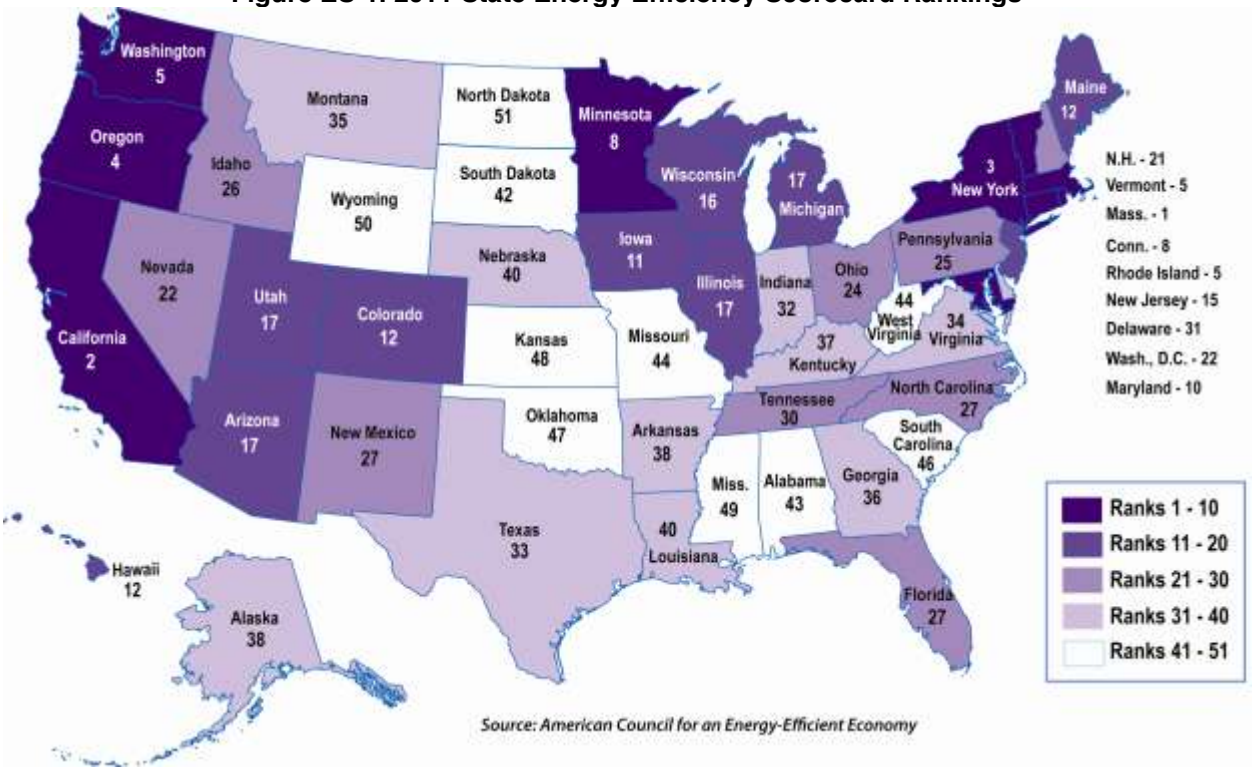
This year's "top ten" states, based on their combined scores, are listed in Table ES-2, along with the "top ten" states from last year's *Scorecard*. These states lead the nation in encouraging their citizens to improve efficiency in homes, businesses, industry, and transportation systems. Massachusetts ranks first

[1] See www.aceee.org/sector/state-policy.

over California, which had placed first in our previous four *Scorecards*. New York, Oregon, Vermont, Washington, Rhode Island, Connecticut, Minnesota, and Maryland round out the top ten this year. While the 2011 top ten are mostly the same as in the *2010 Scorecard*, Maryland has reached the first tier of states for the first time.

Although we list individual state rankings, the variation among states' energy efficiency policies and programs is better measured using tiers of ten ranks rather than by the individual rankings. For example, the difference among states listed in the "top ten" is much less significant than the difference between the tier of top ten and the second or third tier. Figure ES-1 and Table ES-1 sort the state rankings in five tiers, which is the best way for readers to interpret the results of the *2011 Scorecard*. The last column shows the state's change in ranking compared to the *2010 Scorecard*. Readers should note an important caveat: changes in state rankings are due to *both* changes in the scoring methodology as well as changes in state efficiency programs and policies.

Figure ES-1. 2011 State Energy Efficiency Scorecard Rankings



Notes: Several states have the same score and tie for the same ranking, including 5, 8, 12, 17, 22, 27, 38, and 44. We do not score the U.S. territories due to lack of data, though hope to include them in future rankings.

Table ES-1. Summary of Overall State Scoring on Energy Efficiency

Rank	State	Utility and Public Benefits Fund Efficiency Programs and Policies Score	Transportation Score	Building Energy Code Score	Combined Heat and Power Score	State Government Initiatives Score	Appliance Efficiency Standards Score	Total Score	Change in Rank from 2010	Change in Score from 2010
Maximum Possible Points:		*20*	*9*	*7*	*5*	*7*	*2*	*50*		
1	Massachusetts	18.5	7	7	5	7	1	45.5	1	3
2	California	17.5	8	7	4	5.5	2	44	-1	-1.5
3	New York	15	6	6	4	6.5	0.5	38	1	3.5
4	Oregon	13.5	6	7	4	6.5	0.5	37.5	-1	0.5
*5	Vermont	19	4	5	3	3	0	34	0	1
*5	Washington	13.5	6	7	4	3	0.5	34	1	2
*5	Rhode Island	18.5	5	5	3	2	0.5	34	2	5
*8	Minnesota	18	2	4	3	6	0	33	0	5
*8	Connecticut	12	6	5.5	5	3.5	1	33	0	5
↑10	Maryland	9.5	7	5.5	4	4	0.5	30.5	6	6.5
11	Iowa	14	1	5	2	5	0	27	1	2.5
*12	Maine	10.5	4	4.5	5	2.5	0	26.5	-2	-0.5
*12	Hawaii	12	3	5	3	3.5	0	26.5	0	2
*12	Colorado	11	2	3.5	4	6	0	26.5	7	4.5
15	New Jersey	8.5	5	4.5	4	3.5	0	25.5	-3	1
16	Wisconsin	11.5	1	5	4	3.5	0	25	-5	-1
*17	Utah	12	1	5.5	3	3	0	24.5	-5	0
↑*17	Illinois	9	3	5	4	3.5	0	24.5	8	6
↑*17	Michigan	10	2	4.5	3	5	0	24.5	10	7
*17	Arizona	11.5	4	3	3	2.5	0.5	24.5	1	1.5
21	New Hampshire	10.5	0	5.5	3	4.5	0.5	24	1	2.5
*22	Nevada	11.5	0	5	3	1.5	1.5	22.5	-3	0.5
*22	District of Columbia	6	4	5.5	4	2.5	0.5	22.5	-3	0.5
24	Ohio	8.5	0	4	5	4.5	0	22	3	4.5
25	Pennsylvania	4	4	5	4	4	0	21	-9	-3
26	Idaho	9	0	6	2	3	0	20	0	2
*27	Florida	3.5	5	5.5	2	3	0	19	3	2
*27	North Carolina	4.5	0	5	4	5.5	0	19	-3	-1
*27	New Mexico	5	2	4.5	4	3.5	0	19	-5	-2.5
↑30	Tennessee	2	4	4	3	5.5	0	18.5	5	7.5
31	Delaware	2.5	3	4.5	3	4.5	0	17.5	-4	0
32	Indiana	6.5	0	4	3	3.5	0	17	-1	0.5
33	Texas	3	0	4.5	4	4	0	15.5	-1	1
34	Virginia	2	1	5	3	3	0	14	0	2.5
35	Montana	4.5	0	5.5	1	2.5	0	13.5	-2	-0.5
36	Georgia	1.5	2	6.5	0	2.5	0.5	13	1	3
37	Kentucky	3.5	0	4.5	1	3	0	12	-1	1.5
*38	Alaska	0	1	2	2	6	0	11	-1	1
*38	Arkansas	5.5	0	2.5	1	2	0	11	3	3.5
↑40	Nebraska	1.5	0	5	1	2.5	0	10	7	6

Rank	State	Utility and Public Benefits Fund Efficiency Programs and Policies Score	Transportation Score	Building Energy Code Score	Combined Heat and Power Score	State Government Initiatives Score	Appliance Efficiency Standards Score	Total Score	Change in Rank from 2010	Change in Score from 2010
40	Louisiana	2.5	1	4	0	2.5	0	10	2	3
42	South Dakota	4.5	0	0	3	2	0	9.5	-3	0
↑43	Alabama	2.5	0	4.5	0	2	0	9	6	6
*44	Missouri	2.5	0	2	1	3	0	8.5	-1	2.5
*44	West Virginia	0	1	3	2	2.5	0	8.5	-1	2.5
46	South Carolina	1.5	0	3	1	2.5	0	8	-6	-0.5
47	Oklahoma	2.5	1	1.5	0	1.5	0	6.5	-4	0.5
48	Kansas	1	0	1.5	1	2	0	5.5	-2	0.5
49	Mississippi	0.5	0	0	1	2.5	0	4	1	2
50	Wyoming	2	0	0	0	1.5	0	3.5	-2	0
51	North Dakota	0	1	0	1	0.5	0	2.5	0	1

Notes: ↑ denotes "most improved" states. *States with the same score tie for the same rank.

Table ES-2. Top Ten States for the 2011 and 2010 *Scorecards*

2011 Edition		2010 Edition	
1	Massachusetts	1	California
2	California	2	Massachusetts
3	New York	3	Oregon
4	Oregon	4	New York
5 (tie)	Vermont	5	Vermont
5 (tie)	Washington	6	Washington
5 (tie)	Rhode Island	7	Rhode Island
8 (tie)	Minnesota	8 (tie)	Connecticut
8 (tie)	Connecticut	8 (tie)	Minnesota
10	Maryland	10	Maine

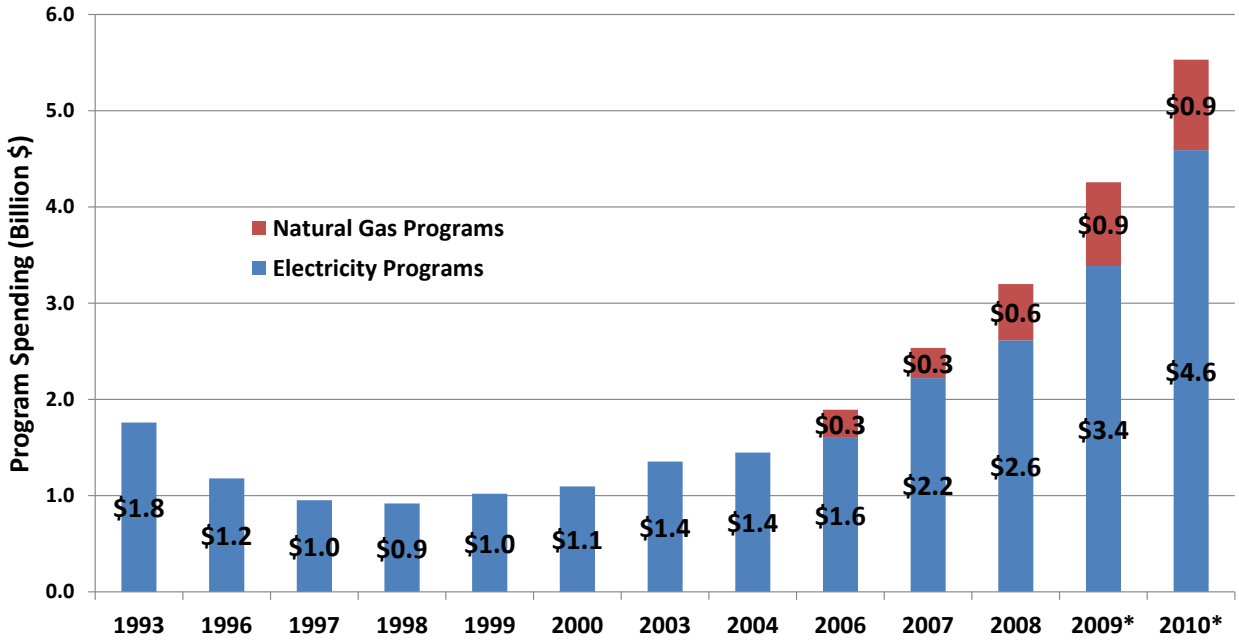
Major Recent Developments

States continue to encourage investments in energy-efficient technologies and practices in homes and businesses and on the road through policies and programs that save energy consumers money. Nationwide, states budgeted $5.5 billion for ratepayer-funded electricity and natural gas efficiency programs in 2010, up from expenditures of $4.3 billion in 2009 (see Figure ES-2). Utility-sector spending on energy efficiency has increased annually by an average amount of $900 million since 2006. Many states have entered a critical phase in energy-efficiency program and policy implementation. With foundational policies such as Energy Efficiency Resource Standards in place, states like Ohio, Illinois, and Michigan have ramped up energy efficiency efforts significantly over the past year to meet statewide energy savings goals. While the action in the middle-ranking states is encouraging, the highest-ranking states such as Vermont and Massachusetts continue to lead with innovative and aggressive programs and policies to save energy across economic sectors. The leading states will continue to reap the benefits of becoming first-adopters of energy efficiency technologies, cementing their market position as hubs for technological innovation and deployment in the energy efficiency field, thereby creating jobs and economic growth for communities and the state.

While the economy lumbered along in 2011, energy efficiency remains a growth sector that attracts investment and creates jobs. In the states that set up the proper regulatory environment and invested in energy efficiency programs, the results are apparent. New businesses are sprouting up to provide energy efficiency services, new factories are manufacturing energy-efficient technologies for buildings and vehicles, and existing businesses have discovered new markets to break into. State economies enjoy the ripple effects of energy efficiency efforts; as consumers and businesses save on energy costs, they can spend elsewhere in local economies on goods and services that produce more widespread economic benefits than spending on energy bills. [2] In a year of continued economic adversity, energy efficiency offered businesses and consumers opportunities to save and grow.

This year has been politically divisive, but amid the acrimonious debates over state budget deficits, state government policymakers from both sides of the aisle pushed for energy efficiency in homes, businesses, and their own state government facilities. An energy efficiency bill sponsored by Republican legislators in Colorado was signed by a Democratic governor.[3] A Republican-sponsored bill to reduce oil consumption by 50% was enacted in Maine, where Republicans control both houses of the legislature as well as the Governor's office.[4] Major energy efficiency legislation was enacted in both traditionally Republican states (Texas) and Democratic states (New York).[5] State regulators in Arkansas, Rhode Island, and Arizona worked with utilities and adopted significant energy efficiency regulations. Despite significant progress, some states have slowed or stepped backward in the race to save energy. New Jersey and Wisconsin have both diminished investments in utility-sector energy efficiency and Arizona is considering a law that will reduce transportation efficiency in the state.

Figure ES-2. State-Level Energy Efficiency Program Spending or Budgets by Year, 1993–2010



*All values actual program spending (EIA Form 861) except for 2009 and 2010, which are budgets (CEE Annual Industry Reports).
Notes: Includes ratepayer-funded programs. Natural gas efficiency program spending is not available for 1993–2004.
Sources: Nadel et al. (2000); York and Kushler (2002), (2005); Eldridge et al. (2008 and 2009)

[2] For more on the relationship between energy efficiency and economic growth, investment, and job creation, see Ehrhardt-Martinez and Laitner (2008), Neubauer et al. (2011), McKinsey & Company (2009), Hendricks et al. (2010), and Muro et al. (2011).
[3] CO House Bill 1160
[4] Maine LD 553
[5] TX Senate Bill 1125 and HB 51; New York Program Bill 21 (Power NY Act of 2011)

"Most Improved" States

This year's most improved states compared to last year's *Scorecard* include Michigan, Maryland, Illinois, Tennessee, Alabama, and Nebraska (see Table ES-3). Michigan, Illinois, and Maryland are reaping the rewards from Energy Efficiency Resource Standards passed in 2008, which requires the states' utilities and governments to provide portfolios of energy efficiency programs sufficient to meet a specific energy savings target that ramps up over time. Each state increased ratepayer spending on utility-sector energy efficiency programs from negligible levels in 2008 to substantial levels in 2010. Energy savings reflect the increased funding levels in these states, increasing from savings equal to around 0% of retail sales to 0.4% in 2009, which is roughly equivalent to the annual electricity use of 60,000 Illinois households.

Aside from utility-sector energy efficiency, each of these states has made significant strides in other energy efficiency areas. Tennessee, Illinois, and Maryland recently began offering financial incentives for high-efficiency vehicles. Michigan has undertaken significant efforts to retool its manufacturing industry to pursue clean energy technology development. A major piece of this effort is the research, development, and demonstration of energy efficiency technologies. Tennessee, Nebraska, and Alabama passed into law major upgrades to residential and commercial building energy codes in 2011, which will make homes and businesses more comfortable and energy-efficient. Nebraska also continues to be a national leader in the implementation of state government-administered financing programs with the Dollar and Energy Savings Loan Program, which provides a wide range of customer classes with low-interest loans to make energy efficiency upgrades.

Table ES-3. Most Improved States since 2010 *Scorecard*

State	2011 Rank	2010 Rank	2011 Total Score	2010 Total Score
Michigan	17	27	24.5	17.5
Illinois	17	25	24.5	18.5
Nebraska	40	47	10	4
Alabama	43	49	9	3
Maryland	10	16	29.5	24
Tennessee	30	35	18.5	11

Energy Efficiency Performance Metrics by Humboldt State University and the Natural Resources Defense Council (NRDC)

This is the third year that we include in the *Scorecard* a chapter prepared by Humboldt State University and NRDC. Chapter 7 presents and discusses a methodology for an aggregate, state-level metric of energy consumption intensity (ECI) in the residential sector and provides summary results. Whereas the majority of the *Scorecard* tracks policy and program actions and results, the methodology in Chapter 7 identifies changes in actual state energy consumption (i.e., energy consumption per capita) after adjusting for changes due to year-to-year variations in weather.

This research confirms that it is possible to track trends in state energy consumption intensity, even with the imperfect data sets that are currently available. With improvements in the data collection process, the approach could be further strengthened into a powerful tool for evaluating states' progress in reducing energy consumption. The findings from this chapter are not factored into the overall rankings of this Scorecard, but serve as an exploratory exercise in measuring energy consumption trends as a means to understanding energy efficiency.

Conclusion

Energy efficiency is America's abundant, untapped energy resource and the states continue to press forward to reap its economic and environmental benefits. In 2011, the positive trends for state-level energy efficiency emerge clearer than ever with improvements in utility-sector investment and

performance, comprehensive transportation policies, building energy codes, combined heat and power, and state government energy efficiency initiatives. Given the tremendous amount of activity happening in the states, it is critical to recognize best practices and leadership, both to encourage other states to follow and to lay the groundwork for strong federal policy in the future. This state energy efficiency *Scorecard* documents and benchmarks state best practices, recognizes leadership, and provides a roadmap for other states to follow in paving a path toward an energy-efficient economy.

ACKNOWLEDGMENTS

We thank the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) for funding this project. We also thank the many contacts at state energy offices and public utility commissions, too numerous to list here, who provided information on state-specific utility-sector data, energy efficiency policies, and programs. The *Scorecard* is also greatly enhanced by comments received from our peers in the field at national and regional organizations: Ralph Cavanagh, Sierra Martinez, Lara Ettenson, Dylan Sullivan, Justin Horner, Pierre Delforge, and Jamy Bacchus at Natural Resources Defense Council; Howard Geller, Stephen Wiel, Bob Yuhnke, Jeff Schlegel, Ellen Zuckerman, and Christine Brinker, Southwest Energy Efficiency Project; Jim O'Reilly and Josh Craft, Northeast Energy Efficiency Partnerships; John Wilson and Tom Larson, Southern Alliance for Clean Energy; Kevin Cullather and Greg Ehrendreich, Midwest Energy Efficiency Alliance; Paul Karrer and Brian Sernulka, Alliance to Save Energy; Rob Sargent, Environment America; David Terry, Association of State Energy Research Technology and Transfer Institutions and National Association of State Energy Officials; Niko Dietsch and Stacy Angel, U.S. EPA; Sam Krasnow, Environment Northeast; Eric Wong, ICF International; Sean Casten, Recycled Energy; and John Cuttica, University of Illinois at Chicago.

The authors also thank our communications and operations staff for their work publicizing and editing the report. We are particularly grateful for the efforts of Glee Murray, Patrick Kiker, Renee Nida, and Eric Schwass, ACEEE, as well as Debbie Slobe and her staff at Resource Media and Scott Stapf and his staff at the Hastings Company.

INTRODUCTION

In a period of historic economic distress and uncertainty, energy efficiency shines brightly as a solution for saving money, driving investment, and creating jobs. Reaping the benefits of an energy-efficient economy, states from coast to coast are moving forward with the implementation of innovative and impactful energy efficiency policies and programs. This report presents a comprehensive analysis of the program and policy environment supporting energy efficiency at the state level. The ranking format of the *State Energy Efficiency Scorecard* allows us to document best practices, recognize leadership, and provide a roadmap for other states to follow. An annual publication, the *Scorecard* serves as a benchmark for state efforts on energy efficiency policies and programs each year, encouraging states to continue strengthening efficiency commitments as a pragmatic and effective strategy for economic growth and environmental protection.

Building on prior reports that focused on utility spending and savings on energy efficiency programs in each state, ACEEE released *The State Energy Efficiency Scorecard for 2006* (Eldridge et al. 2007) in 2007, providing a more comprehensive approach to scoring and ranking states on energy efficiency policies. Due to the broad interest in the 2007 report and the continued demand for a state-by-state comparison on energy efficiency, we have continued to update the report on an annual basis and present this report as its fifth edition.[6] In the report, we first discuss the methodology for scoring states and some caveats. We then present the detailed results in six chapters, one for each policy area that we review:

1. Utility and Public Benefits Programs and Policies
2. Transportation Policies
3. Building Energy Codes
4. Combined Heat and Power
5. State Government Initiatives
6. Appliance and Equipment Efficiency Standards

The report also includes a chapter prepared by Humboldt State University and the Natural Resources Defense Council on state energy consumption trends and efficiency performance metrics. The findings of that section are not incorporated into the overall scoring; however, they serve as an important complement to our policy *Scorecard*.

Finally, we present a discussion of the *Scorecard* results, which further assists readers with interpreting the rankings and methodology. The chapter highlights the most improved states and other trends in state-level energy efficiency revealed by the rankings. The chapter also focuses on further areas of research and potential changes to the *Scorecard* in 2012.

METHODOLOGY

Scoring

To score states on energy efficiency, we identified six overall policy areas pursued by states to encourage energy efficiency, listed in Table 1 below. In general, the policies and programs scored in this report have one or more of the following objectives:

- Directly reduce energy consumption
- Provide funding for energy efficiency programs
- Set long-term commitments to efficiency
- Reduce market, regulatory, and information barriers to energy efficiency

[6] The National Renewable Energy Laboratory publishes an annual *State of the States* report, which includes rankings of all states based on renewable energy policy and performance (Doris et al. 2009). These reports serve as an excellent complement to our energy efficiency *Scorecard*.

- Establish mandatory performance codes and standards
- Accelerate the adoption of the most energy-efficient technologies

Understanding that every state has different policy and regulatory situations, we have made our best effort to ensure our metrics are flexible enough to capture the full range of policy and program options states employ. We do not report scores for the U.S. territories because the data is unavailable, though we hope to include these in future editions of the *Scorecard*.

Table 1 below shows the six policy categories and the scoring system that assigns a maximum score for each policy category, weighting policy categories based on approximate energy savings impacts (i.e., state policies that are likely to result in the highest energy savings have the highest maximum score). The weighting of policy areas is mostly consistent with last year's scoring, and was informed by ACEEE staff, outside expert judgment, and state and regional studies that have evaluated the relative energy savings impacts from state-level policies (SWEEP 2007; Neubauer et al. 2009b and 2011; Molina et al. 2010 and 2011). For example, the energy efficiency potential studies we reviewed found that utility and public benefits programs could contribute about 40% of the total energy savings potential. Building energy codes, on average, could contribute about 15% of the total savings potential, and improved CHP policies about 10%. We thus attribute 40% of 50 possible points to utility and public benefits program and policy metrics, or 20 points. Similarly, we attribute about 15% of the points, or 7 points, to building energy codes, and 10%, or 5 points, to improved CHP policies. The other policy area points were estimated using the same methodology, then reviewed by expert judgment and adjusted according to review.

Table 1. Overall Methodology: Maximum Scores for each Policy Category

Policy	Maximum Score
1. Utility and Public Benefits Programs and Policies	**20**
Electricity Efficiency Program Budgets	5
Natural Gas Efficiency Program Budgets	3
Annual Savings from Electricity Efficiency Programs	5
Targets (Energy Efficiency Resource Standards)	4
Performance Incentives/Alternative Regulatory Business Models	3
2. Transportation Policies	**9**
3. Building Energy Codes	**7**
Level of Stringency	5
Enforcement/Compliance	2
4. Combined Heat and Power	**5**
5. State Government Initiatives	**7**
Financial and Information Incentives	3
Lead by Example in State Facilities and Fleets	2
Research, Development, and Demonstration	2
6. Appliance and Equipment Efficiency Standards	**2**
Maximum Total Score	**50**

Within each policy category, we then developed a scoring methodology based on a subset of criteria and assigned a score for each state based on extensive review and communication with experts in the field. See each policy chapter for a discussion of its methodology. The only change to the overall methodology in the 2011 update is that appliance and equipment efficiency standards earns 2 points rather than 3 and the maximum score in the transportation policies section increased from 8 to 9. Methodology changes within each policy area are discussed in each chapter.

Changes in Scoring

Some minor changes in scoring methodology compared to last year may affect some of the overall rankings. Full explanations for the methodology changes are presented within the chapters. We revised the Utility and Public Benefits Programs and Policies chapter methodology for scoring performance incentives and alternative regulatory business models for utilities to better capture the wide range of strategies undertaken by states. We also refined our scoring for Energy Efficiency Resource Standards to better reflect the impact of cost caps and exit ramps on policy success.

In the Transportation chapter, we placed greater emphasis on policies that integrate land use and transportation planning. Sound land use planning is vital in order to stem growth in vehicle miles travelled in the United States. Because energy-efficient transportation is inherently tied to the integration of transportation and land use policies, we awarded points for states that simultaneously address land use and transportation considerations in planning processes. We also awarded states a point for the adoption of complete streets policies, which focus on the interconnectivity of streets and target safe, easy access to roads by all pedestrians, bicyclists, motorists, and public transportation users. We reduced the appliance standards metric from three to two points and increased the transportation score from eight to nine points.

In the Building Energy Codes chapter, we amended the methodology so that states earning the top score for code stringency exceed 2009 IECC, ASHRAE 90.1-2007, or equivalent standards. In the 2009 and 2010 *Scorecard* reports we allotted the maximum code stringency score for states meeting these standards, but this year around twenty states were receiving maximum scores for building code stringency. Given that a number of states now go beyond 2009 IECC and equivalents, the new methodology reflects the efforts of states to go above and beyond stringent codes and adopt standards that will result in the construction of exceptionally efficient and comfortable buildings.

We have also slightly changed the scoring methodology in the Building Energy Codes chapter to award credit for states without statewide mandatory building energy codes for various levels of adoptions by major jurisdictions. Many “home rule” states, such as Colorado, Missouri, and Oklahoma, do not have mandatory statewide codes and, instead, adopt and enforce building energy codes at the local level. Some of these jurisdictions are major urban areas that have adopted the American Recovery and Reinvestment Act (ARRA) codes and should be given credit for their efforts.

In the State Government Initiatives chapter, we have included a new metric measuring state government policies and programs enabling the use of energy savings performance contracts (ESPCs), which allow states to enter into a performance-based agreement with an Energy Service Company (ESCOs). The contract allows the state to pay the ESCO for its services with money saved from installed energy efficiency measures.[7]

State Feedback Methodology

We continued to improve our outreach to state-level stakeholders to verify the accuracy and comprehensiveness of the policy information on which we score the states. This year we reached out to every state utility commission to confirm spending and savings data for ratepayer funded programs presented in Chapter 1. State energy officials were given the opportunity to review the material concurrently on the ACEEE State Energy Policy Database[8] on our Web site and in the draft *2011 State Energy Efficiency Scorecard* report. Regional nonprofits and other state-level organizations also contributed to the review process.

[7] For a full discussion of ESPCs and the ESCO market, see Satchwell et al. (2010).
[8] The State Energy Efficiency Policy Database houses most of the policy and program information presented in the *Scorecard.* For detailed understanding of the policies we reference for this report, visit www.aceee.org/energy/state.

Data Caveats

The *Scorecard* reflects state-level energy efficiency policy environments as well as the performance of states implementing energy efficiency programs. Readers should note that the energy efficiency initiatives implemented by actors at the federal and local level as well as in the private sector are not included. Regions, counties, and municipalities have become very active in energy efficiency program development, a positive development that should reinforce the energy efficiency efforts taking place at the state level.[9] Additionally, private sector investment in efficient technologies outside the utility sector is not covered in the *Scorecard.* While utility and public programs are critical to leverage private capital, an independent metric measuring private sector investment would involve layers of complexity far beyond the scope of this report.[10]

"Best Practice" Policy and Performance Metrics

The scoring framework described above is our best attempt to represent the myriad efficiency metrics as a quantitative "score." The conversion of spending data, energy savings data, and policy adoption metrics across six policy areas into one state energy efficiency score has clear limitations. Performance metrics are confined mostly to the electric efficiency. Due to data lags, these performance metrics reflect activity in 2010 rather than 2011. Policy information for the *Scorecard* is accurate as of September 2011. We continue to search for ways to gauge actual performance and implementation rather than scoring on "best practice" policies. Gathering comprehensive data for all states on the actual energy saved or funds spent on energy efficiency technologies across public and private sectors is the primary challenge going forward.

In lieu of scoring energy efficiency policy areas on reported savings or spending data attributable to a particular policy action, we have developed "best practice" metrics to score the states. Policies considered best practices will result in the greatest amount of cost-effective energy and cost savings. For example, *potential* energy savings from building energy codes and appliance efficiency have been documented, although *actual* savings from these policies are rarely evaluated. Therefore, we must rely on "best practice" metrics for building energy codes. For building energy codes, we rank states according to the level of stringency of their residential and commercial codes. Understanding that policies are only effective if they are implemented properly, we have adjusted our scoring metrics to reflect actual policy implementation for numerous policy areas. We afford states points for building code compliance, for example, to underscore the importance of enforcement. Full discussions of the policy and performance metrics used can be read in each chapter.

How to Interpret the Results

Although we provide individual state scores and rankings, we note that the difference between rankings is most significant in "bins" of ten or fifteen, rather than differences between individual rankings. As we describe above, despite intensive data collection and interviews, the methods underpinning *Scorecard* are not an exact science. The tiers of ten, as presented in Figure ES-1, are therefore the best way to interpret the results of the *Scorecard.*[11]

[9] For more information on local energy efficiency policy, visit http://www.aceee.org/sector/local-policy
[10] The *Scorecard* also does not provide scores for the growing array of quasi-governmental energy efficiency financing programs, such as on-bill financing and Property Assessed Clean Energy (PACE). In the final chapter we discuss our intentions to research the area of energy efficiency finance further for future iterations of the *Scorecard*.
[11] The fourth tier of states includes eleven states as the inclusion of the District of Columbia makes our count 51.

CHAPTER 1: UTILITY AND PUBLIC BENEFITS PROGRAMS AND POLICIES

Authors: Michael Sciortino, Seth Nowak, and Sara Hayes

Background

The utility sector is critical to the implementation of energy-efficient technologies and practices. Electric and natural gas utilities as well as statewide independent program administrators administer and deliver a substantial share of U.S. electric and natural gas efficiency programs.[12] Utility ratepayers fund these programs, either through utility cost recovery or statewide "public benefits funds." Driven by effective regulation from state utility commissions, utilities and third-party program administrators in some states have been delivering energy efficiency programs for decades, and offer various efficiency services for residential, commercial, industrial, and low-income customers. Almost every state implements utility-sector energy efficiency programs today. Energy efficiency programs include a variety of financial incentives such as rebates and loans, technical services such as audits and retrofits, or broad scale education campaigns on the benefits of energy efficiency improvements.

In this chapter, we review and rank the states based on metrics that measure states' performance implementing utility-sector efficiency programs as well as enabling policies that provide a measure of states' present and future commitment to energy efficiency. The five subsets of scoring in this chapter include:

- Electricity Program Budgets for 2010
- Natural Gas Program Budgets for 2010
- Incremental Electricity Program Savings in 2009
- Energy Savings Targets, i.e., Energy Efficiency Resource Standards (EERS)
- Performance Incentives and Alternative Regulatory Business Models

Methodology

Combined, a state can earn up to 20 points in this category, or 40% of the total possible 50 points. Among efficiency programs, studies suggest that electric programs typically achieve three times as much primary energy savings as natural gas programs (Eldridge et al. 2009; SWEEP 2007). We thus allocate 10 points of this category to electric program performance metrics (annual budgets and savings data) and 3 points to natural gas program performance metrics (annual budgets).[13] Using baseline data from the Consortium for Energy Efficiency and the Energy Information Administration, we report 2010 program budgets for electricity and natural gas programs and 2009 electricity savings data (CEE 2010 and EIA 2011). We supplemented these datasets with additional research and information requests to state utility commissions. While we use EIA and CEE data, the analysis is solely a product of ACEEE.[14]

Supporting policies are also critical to leveraging energy efficiency funding and encouraging savings over the near and long term. In this chapter we credit states with Energy Efficiency Resource Standards (EERS—mandatory energy savings targets) and regulatory mechanisms that provide incentives and remove disincentives for utilities to pursue energy efficiency (performance incentives

[12] The other major programs are run by state governments, which are discussed in chapter 5. Additionally in 2011, programs funded by the American Recovery and Reinvestment Act (ARRA) complemented utility program offerings. For an analysis of how ARRA and utility programs interacted, see (Goldman et al 2011).

[13] Energy savings data for natural gas programs are not tracked through a national clearinghouse and are not readily reported by states, so these data do not appear in the scoring. Similarly, programs that save home heating fuel or propane do not systematically report energy savings. In future editions of the *Scorecard*, we plan to examine metrics for energy savings from natural gas, fuel oil, and propane efficiency.

[14] While we have attempted to present the most accurate statewide spending and savings data possible, they should be viewed as imperfect due to the disparate and uneven nature of energy efficiency reporting. We discuss this issue in greater detail in the Conclusion.

and decoupling/lost revenue adjustment mechanisms). We rely on primary reference material (i.e. legislation, commission dockets) for our research. Combined, we allocate seven points to these supporting state policies to emphasize the importance of an effective regulatory environment in promoting energy efficiency and to capture recent advancements not yet reflected in 2010 budget and 2009 savings data. See Table 2 for a summary of state scoring in the five subsets to this policy category.

It should be noted that our chosen methodology does put a handful of states at a disadvantage due to the primary fuels used by utilities. In Hawaii, for example, there is no natural gas service for customers, so energy efficiency is purely aimed at reducing electricity. Thus, the state cannot earn four points (three for budgets, one for gas decoupling and performance incentives) that other states may earn. In other states, energy efficiency efforts may aim to reduce fuel oil consumption, which is not captured in the metrics we use. States with major fuel oil reduction programs are concentrated in the northeast. Despite these drawbacks, we find that our methodology is still the most appropriate measure of utility and public benefits programs and policies advancing energy efficiency.

Table 2. Summary of State Scoring on Utility and Public Benefits Programs and Policies

Rank	State	Electricity Program Budgets for 2010	Electricity Program Savings for 2009	Gas Program Budgets for 2010	Targets (Energy Efficiency Resource Standards)	Utility Incentives and Removal of Disincentives	TOTAL SCORE
	Maximum Possible Points:	*5*	*5*	*3*	*4*	*3*	***20***
1	Vermont	5	5	3	4	2	19
2	Massachusetts	5	3.5	3	4	3	18.5
2	Rhode Island	5	4	2.5	4	3	18.5
4	Minnesota	5	4	2.5	4	2.5	18
5	California	5	3.5	2.5	3.5	3	17.5
6	New York	4.5	2.5	1	4	3	15
7	Iowa	3.5	3.5	3	3.5	0.5	14
8	Oregon	5	2.5	2.5	2	1.5	13.5
8	Washington	5	3	1	3	1.5	13.5
10	Hawaii	1.5	4.5	0	4	2	12
10	Utah	5	2.5	3	0	1.5	12
10	Connecticut	4.5	3.5	2	0	2	12
13	Wisconsin	2.5	3.5	3	0	2.5	11.5
13	Nevada	2.5	5	0.5	2	1.5	11.5
13	Arizona	2.5	3	0.5	4	1.5	11.5
16	Colorado	2.5	2	1	3	2.5	11
17	Maine	2	3	1.5	3	1	10.5
17	New Hampshire	3	2.5	3	0	2	10.5
19	Michigan	1.5	1.5	1	3	3	10
20	Maryland	2	1.5	0.5	3.5	2	9.5
21	Idaho	4.5	3	0.5	0	1	9
21	Illinois	2.5	1.5	0.5	3.5	1	9
23	New Jersey	3	2.5	2.5	0	0.5	8.5
23	Ohio	2	1.5	0.5	2.5	2	8.5
25	Indiana	0	0	1	3	2.5	6.5

Rank	State	Electricity Program Budgets for 2010	Electricity Program Savings for 2009	Gas Program Budgets for 2010	Targets (Energy Efficiency Resource Standards)	Utility Incentives and Removal of Disincentives	TOTAL SCORE
26	District of Columbia	1	1.5	1	0	2.5	6
27	Arkansas	0.5	0.5	1	2	1.5	5.5
28	New Mexico	1.5	1	0.5	1.5	0.5	5
29	Montana	1.5	1.5	0	0	1.5	4.5
29	South Dakota	0.5	0.5	1	0	2.5	4.5
29	North Carolina	0.5	0	0.5	1	2.5	4.5
32	Pennsylvania	1	0.5	0.5	2	0	4
33	Kentucky	0.5	0	0.5	0	2.5	3.5
33	Florida	1	0.5	1	0	1	3.5
35	Texas	0.5	0.5	0	1	1	3
36	Missouri	1	0	0.5	0	1	2.5
36	Oklahoma	1	0	0	0	1.5	2.5
36	Alabama	0	0	0	0	2.5	2.5
36	Louisiana	0	0	0	0	2.5	2.5
36	Delaware	0.5	0	1	0	1	2.5
41	Wyoming	0.5	0	0.5	0	1	2
41	Tennessee	1	0.5	0	0	0.5	2
41	Virginia	0	0	0.5	0	1.5	2
44	Georgia	0	0	0	0	1.5	1.5
44	South Carolina	0	0	0	0	1.5	1.5
44	Nebraska	1	0.5	0	0	0	1.5
47	Kansas	0	0	0	0	1	1
48	Mississippi	0.5	0	0	0	0	0.5
49	North Dakota	0	0	0	0	0	0
49	Alaska	0	0	0	0	0	0
49	West Virginia	0	0	0	0	0	0

Electricity and Natural Gas Efficiency Program Budgets

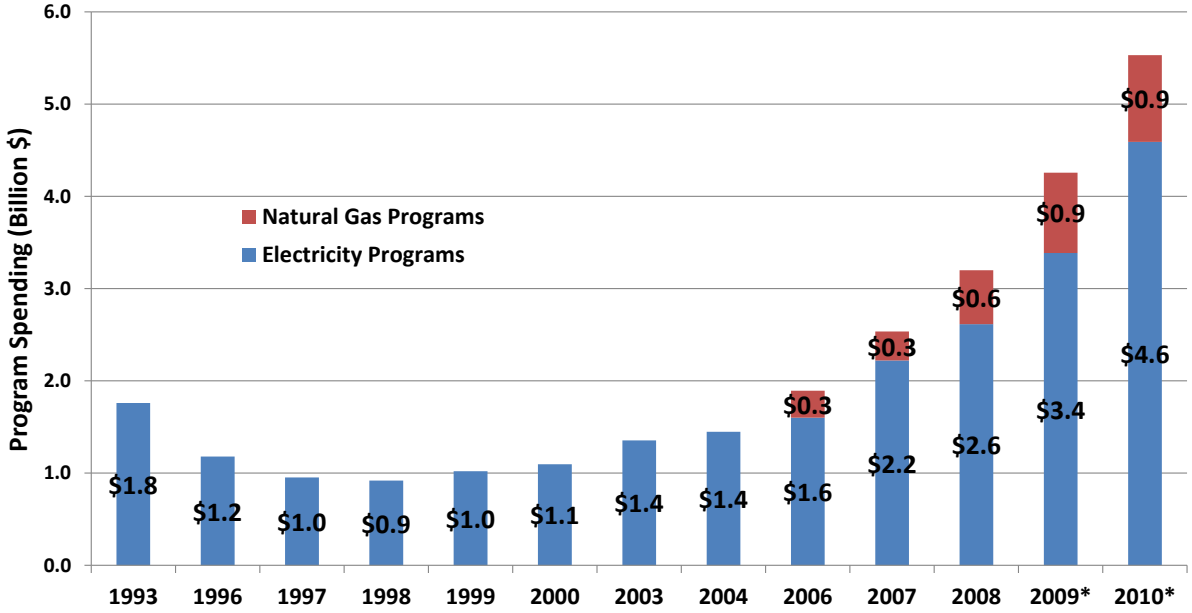
The structure and delivery of ratepayer-funded electric energy efficiency programs[15] have changed dramatically over the past two decades, mostly in conjunction with restructuring efforts. In the 1980s and 1990s, such programs were almost the exclusive domain of utilities; they administered and implemented programs under regulatory oversight. With the advent of restructuring, however, numerous states enacted "public benefits" energy programs that in many cases established new structures and tasked new organizations with the responsibility of administering and delivering energy efficiency and related customer energy programs (including low-income energy programs and renewable energy programs). Not all public benefits programs are administered or delivered by non-

[15] By "ratepayer-funded energy efficiency" programs, we mean energy efficiency programs funded through charges included in customer rates or otherwise paid via some type of charge on customer utility bills. This includes both utility-administered programs and "public benefits" programs administered by other entities. We do not include data on separately funded low-income programs, load management programs, or energy efficiency research and development.

utility organizations, however. In quite a few cases there is a public benefits funding mechanism, but the funds go to the utilities to administer and implement the programs.

Despite the enactment of public benefits programs in some states, restructuring resulted in a precipitous decrease in funding for ratepayer-funded electric energy efficiency programs, from almost $1.8 billion in 1993 to about $900 million in 1998 (nominal dollars). Principal reasons for this decline included uncertainty about newly restructured markets and the expected loss of cost recovery mechanisms for energy efficiency programs. Generally utilities did not see demand-side programs as being compatible with competitive retail markets. Since then, however, efficiency programs have entered a new era of renewed focus and importance. Since 1998, spending has increased more than three-fold from $900 million to about $3.4 billion in 2009 for electricity programs. And in 2010, total budgets for electricity efficiency programs reached about $4.5 billion. Combined with natural gas program budgets of $1 billion in 2010 (discussed later in this chapter), we estimate total budgets of about $5.5 billion on efficiency programs in 2010 (see Figure 1). Given the increasing regulatory commitments to energy efficiency, this growth will likely continue over the next decade.

Figure 1. Annual Electricity and Natural Gas Energy Efficiency Program Spending or Budgets



*All values are actual program spending except for 2009 and 2010, which are budgets. Notes: Includes ratepayer-funded programs. Natural gas efficiency program spending is not available for 1993–2004. Sources: Nadel et al. (2000); York and Kushler (2002), (2005); Eldridge (Molina) et al. (2008), (2009), (2010).

An analysis of state-level energy efficiency policies estimates that ratepayer funding for electric and natural gas energy efficiency programs could rise to $12.4 billion by 2020 (Barbose, Goldman, and Schlegel 2009). In addition to increased spending, the study also suggests a significant broadening of the national energy efficiency market, with a large portion of the projected spending increase coming from states that have historically been relatively minor players in the industry (e.g., Illinois, Michigan, North Carolina, Ohio, and Pennsylvania).

Electricity Program Budgets and Actual Spending

For this section of the report, we score states on reported annual energy efficiency electricity program budgets for 2010. The data presented in this section are for "ratepayer-funded energy efficiency" programs, or energy efficiency programs funded through charges included in customer utility rates or otherwise paid via some type of charge on customer bills. This includes budgets for both utility-administered programs, which depending upon the state may include investor-owned utilities (IOUs), municipal utilities, cooperative utilities, other public power companies or authorities, and for

ratepayer-funded "public benefits" programs administered by other entities. We did not collect data on the federal Weatherization Assistance Program (WAP), which gives money to states on a formula basis. Revenues from the Regional Greenhouse Gas Initiative (RGGI) that contribute to ratepayer-funded energy efficiency program portfolios *are included* in this chapter. However, when RGGI funds are channeled to energy efficiency initiatives implemented by state governments, we have included them in Chapter 5. Similarly, Chapter 5 accounts for applicable funding from the American Recovery and Reinvestment Act that is contributing to energy efficiency programs.

Last year, we shifted from using actual spending on energy efficiency programs to budget figures. In the past we used data gathered by the Energy Information Administration, which reports actual spending with a two-year lag. The rapid increases in energy efficiency funding made it necessary to instead use a data-set that captured a more recent snapshot of energy efficiency funding. The Consortium for Energy Efficiency's *Annual Industry Reports*[16] present energy efficiency budgets from the prior year, so in order to improve the timeliness of the *Scorecard*, we decided to shift towards budget data, principally drawn from CEE's report, which we supplement with information from individual contacts at state utility commissions.

Our energy efficiency budget data differs from the CEE industry data in important ways. This year, we reached out to every state utility commission to confirm energy efficiency spending. During this feedback process with our state contacts, several states provided *revised budget data* that differed from budget data in CEE's report. [17] We seek to provide the most accurate and current information on a state's financial commitment to energy efficiency programs, so we have ranked states on the revised budget data in these cases. See Tables 4 and 6 for detail on which states reported revised budget data. Additionally, CEE includes load management program spending in its overall electric program budgets, whereas we exclude these program budgets.

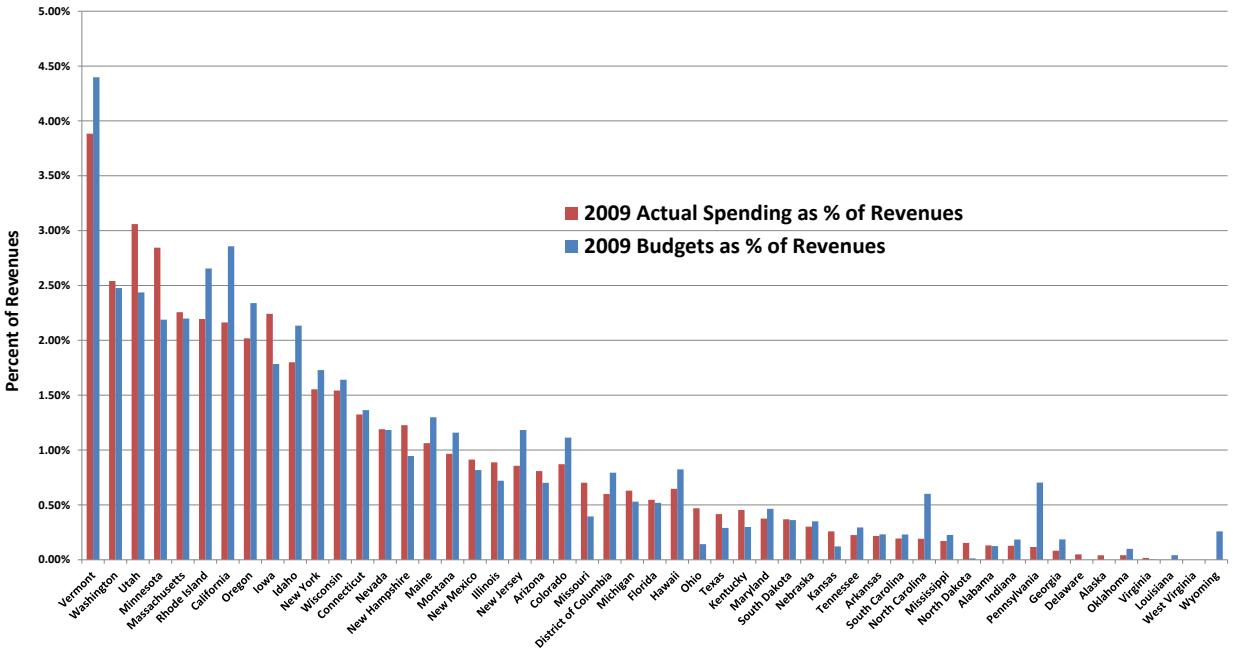
Even with this updated approach to capture more recent program budget data, our methodology still does not fully capture energy efficiency program activity in 2011. Several states are rapidly advancing energy efficiency programs in response to a wave of Energy Efficiency Resource Standards that were passed from 2007 to 2010. Budgets in 2011 will almost certainly be higher in states such as Pennsylvania, Ohio, Michigan, Illinois, Arizona, Rhode Island, and Massachusetts. Utilities in other states such as Georgia and Oklahoma have also moved forward with efficiency program portfolios that should produce results in future *Scorecards.*

On the other side of the coin, these budget figures do not reflect recent energy efficiency budget raids, which are of particular concern in New Jersey, where Governor Christie raided $42.5 million from the state's Clean Energy Fund in FY 2011 to pay state energy bills and proposes to do the same in FY 2012 (NJ Spotlight 2011). Continuing its reversal of progress on energy efficiency, New Jersey is planning to pull out of the Regional Greenhouse Gas Initiative, which had been providing the state with substantial funding for cost-saving energy efficiency projects. The state continues to raid budget funds from its Clean Energy Program to shore up the state budget deficit. In Wisconsin, only months after the state utility commission and a joint committee increased funding increases for energy efficiency, the state legislature repealed the increase and also revoked the Public Service Commission's ability to request energy efficiency funding levels above 1.2% of revenues – a level that essentially flat-lines efficiency spending in the state. Wisconsin's third-party program administrator, Focus on Energy, had previously been approved by the Legislature's Joint Finance Committee based on a recommendation by the Public Service Commission of Wisconsin to ramp up spending from $120 million in 2011 to $256 million in 2014, which would result in annual electric and natural gas savings of 1.5% and 1%, respectively. By repealing this approved increase, Wisconsin will not reach its achievable energy efficiency potential.

[16] Consortium for Energy Efficiency, Annual Industry Reports, Web http://www.cee1.org/ee-pe/AIRindex.php3 2006–2010.
[17] Because utility commissions do not have jurisdiction over municipal and cooperative utilities, we could not confirm the data reported by EIA and CEE for these utilities.

It is also important to clarify that budget data captures intention rather than the execution of energy efficiency spending. The data shows, however, that budget figures have been highly consistent with actual spending. For 2009, our first year for which we tracked both spending and budgets, we found that actual spending was about 90% of the reported budget figures. Nationwide, electric efficiency program budgets totaled around $3.4 billion in 2009, compared to actual spending of $3.1 billion.[18] As Figure 2 depicts, however, some states had significant gaps between budgets and actual spending. Gaps could be explained by lags in program initiation, unforeseen outcomes in program implementation and customer participation, or the ability to deliver program more cost-effectively than anticipated. We recommend a thorough examination of the factors underlying the difference between spending and budgets, which would require research outside the scope of this report.

Figure 2. 2009 Electricity Efficiency Program Spending vs. Budgets



Scoring

Even though a handful of states spent far less (or far more) than they had budgeted, the use of budget figures for the *Scorecard* allows us to present a more up-to-date picture that reflects a state's commitment to energy efficiency programs. States are scored on a scale of 0 to 5 based on levels of energy efficiency budgets as a percent of utility revenues.[19] Budgets representing at least 2.5% of revenues earn the maximum 5 points. For every 0.25% less than 2.5%, a state's score decreases by 0.5 points. Table 3 lists the scoring bins for each level of spending and Table 4 shows state-by-state results and scores for this category.

[18] It should be noted that the budget and spending figures for 2009 are based on two separate data sources. Budget figures for 2009 are drawn from CEE and actual spending data is acquired from EIA and commission staff. CEE reports actual expenditures of $2.98 billion for 2009 U.S. electric efficiency programs in its latest Annual Report. While we have made a good faith effort to ensure the actual spending figure reflects the same utilities that are accounted for in the budget figure, there may be some inconsistency. Budget figures in 2009 have also been revised from last year's Scorecard when we have received corrections (Hawaii). While the data is imperfect, it should give the reader an overall sense of how well budget commitments are being kept.

[19] Statewide revenues drawn from (EIA 2011d). We measure budgets as a percentage of savings to accurately demonstrate the magnitude of energy efficiency spending. Blending utility revenues from all customer classes gives a more accurate measure of its overall spending on EE than expressing budgets per capita, which might skew the data for utilities with a few very large customers (and hence large revenues). Statewide electric energy efficiency budgets per-capita are presented in Appendix A.

Table 3. Scoring Metrics for Electricity Efficiency Program Budgets

Range of Budgets as Percent of Revenues	Score
2.5% or greater	**5**
2.25% – 2.49%	**4.5**
2.00% – 2.24%	**4**
1.75% – 1.99%	**3.5**
1.50% – 1.74%	**3**
1.25% – 1.49%	**2.5**
1.00% – 1.24%	**2**
0.75% – 0.99%	**1.5**
0.50% – 0.74%	**1**
0.25% – 0.49%	**0.5**
Less than 0.25%	**0**

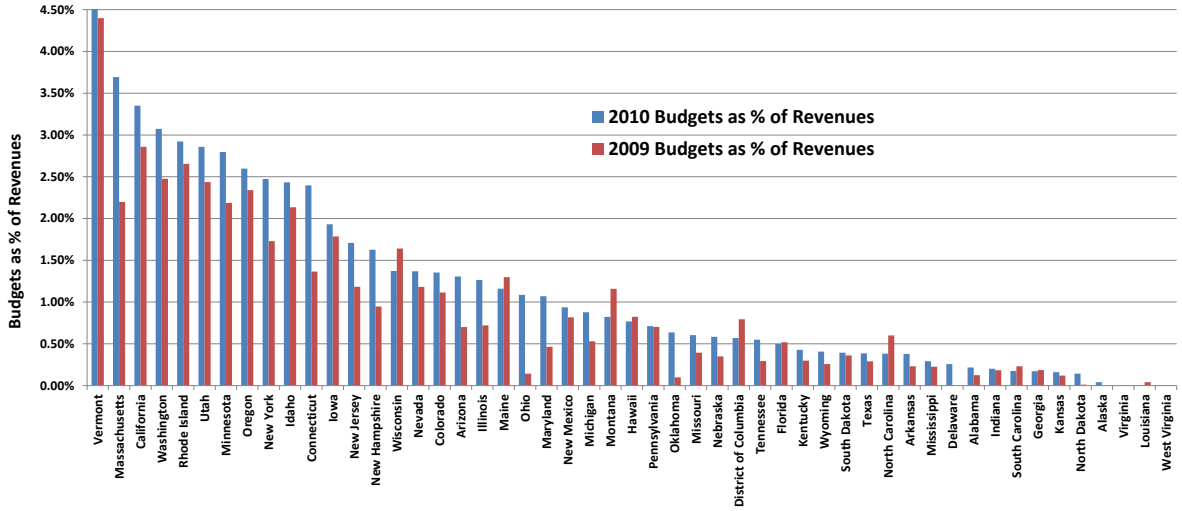
Table 4. 2010 Electricity Efficiency Program Budgets by State

Rank	State	2010 Budgets (Million $)	Budgets as Percent of Revenues	Score
1	Vermont[1]	$34.0	4.57%	5.0
2	Massachusetts[2]	$301.9	3.69%	5.0
3	California	$1,158.1	3.42%	5.0
4	Washington[2b]	$184.9	3.35%	5.0
5	Rhode Island[3]	$32.1	2.92%	5.0
6	Utah[4]	$55.5	2.86%	5.0
7	Minnesota[5]	$160.2	2.80%	5.0
8	Oregon	$91.1	2.60%	5.0
9	New York[6]	$583.6	2.47%	4.5
10	Idaho[7]	$36.1	2.43%	4.5
11	Connecticut[8]	$126.9	2.18%	4.5
12	Iowa	$67.8	1.93%	3.5
13	New Jersey[9]	$198.1	1.63%	3.0
14	New Hampshire[10]	$26.3	1.40%	3.0
15	Wisconsin	$92.3	1.37%	2.5
16	Nevada	$45.0	1.37%	2.5
17	Colorado	$64.7	1.35%	2.5
18	Arizona[10b]	$92.3	1.26%	2.5
19	Illinois[11]	$165.5	1.23%	2.5
20	Maine	$14.0	1.16%	2.0
21	Ohio	$152.8	1.09%	2.0
22	Maryland[12]	$88.8	1.07%	2.0
23	New Mexico	$17.5	0.94%	1.5
24	Michigan[13]	$91.5	0.88%	1.5
25	Montana	$8.9	0.82%	1.5
26	Hawaii	$19.3	0.77%	1.5
27	Pennsylvania	$110.0	0.71%	1.0
28	Oklahoma	$27.9	0.64%	1.0
29	Missouri[14]	$40.5	0.60%	1.0

Rank	State	2010 Budgets (Million $)	Budgets as Percent of Revenues	Score
30	Nebraska	$13.0	0.58%	1.0
31	District of Columbia[15]	$9.4	0.57%	1.0
32	Tennessee	$48.9	0.55%	1.0
33	Florida	$123.2	0.50%	1.0
34	Kentucky	$27.1	0.43%	0.5
35	Wyoming	$4.3	0.41%	0.5
36	South Dakota[16]	$3.5	0.39%	0.5
37	Texas[17]	$128.4	0.39%	0.5
38	North Carolina	$45.3	0.38%	0.5
39	Arkansas	$13.1	0.38%	0.5
40	Mississippi	$12.5	0.29%	0.5
41	Delaware[18]	$3.6	0.22%	0.5
42	Alabama	$17.7	0.20%	0.0
43	Indiana	$16.5	0.18%	0.0
44	South Carolina	$12.3	0.17%	0.0
45	Georgia	$21.6	0.16%	0.0
46	Kansas[19]	$5.4	0.14%	0.0
47	North Dakota[20]	$1.3	0.12%	0.0
48	Alaska[20]	$0.4	0.04%	0.0
49	Virginia	$0.2	0.00%	0.0
50	Louisiana	$0.0	0.00%	0.0
50	West Virginia	$0.0	0.00%	0.0
	U.S. Total	**$4,595.7**	**1.18% (Average)**	

NOTES: All data are based on CEE (2011) unless otherwise noted here. [1] VT PSB (2011) [2] MA DOER (2011); [26] Washington's budget figure includes pro-rated share of Bonneville Power Authority (BPA) and Northwest Energy Efficiency Alliance (NEEA) budgets in addition to CEE total of $132.4 million. BPA and NEEA are incorporated in Idaho and Oregon budgets as well. [3] RI PUC (2010a); [4] RMP (2010); [5] MN PUC (2011); [6] NYSERDA (2011a); [7] ID PUC (2011); [8] CT ECMB (2010); [9] AEG (2011); [10] NH PUC (2011). [10b] Includes savings for Salt River Project claimed in (Salt River Project 2010). [11] IL DCEO (2011); [12] MD PSC (2011); [13] MI PSC (2010); [14] MO PSC (2011) [15] DDOE (2011) [16] SD PUC (2011); [17] Frontier Associates (2011)[18] Delaware's Sustainable Energy Utility administers energy efficiency programs using RGGI funding and some state funding and had a budget of about $4.78 million in 2010. The budget is broken down to 75% for electricity programs and 25% to natural gas programs (DNREC 2011).[19] KCC (2011). [20] Actual Spending for 2009 (EIA 2010a).

Figure 3: Electric Energy Efficiency Program Budgets in 2009 and 2010



Natural Gas Program Budgets

In addition to efficiency programs targeting end-use electricity consumption, we also score states on natural gas efficiency program budgets by awarding up to three points based on 2010 program budget data as reported in the CEE *Annual Report.* In order to directly compare state spending data, we normalize spending to the number of residential natural gas customers by state, which reflects the fact that some states do not have natural gas service for customers throughout the state.[20] Table 5 shows scoring bins for natural gas program spending and Table 6 shows state scoring results. For 2010, natural gas programs budgets totaled about $1.1 billion.

Table 5. Scoring Metrics for Natural Gas Utility and Public Benefits Spending

Budget Range ($ per customer)	Score
$35 or greater	3
$28–34.99	2.5
$21–27.99	2
$14–20.99	1.5
$7–13.99	1
$1—6.99	0.5
Less than $1	0

[20] Residential natural gas customers totals drawn from (EIA 2011a). We use per-capita spending for natural gas because data because revenue data is more difficult to access for natural gas utilities than for electric utilities.

Table 6. 2010 Natural Gas Program Budgets by State

Rank	State	2010 Program Budgets (Million $)[1]	Budgets Relative to Residential Customers ($ per customer)	Score
1	New Hampshire[2]	$6.2	$64.0	3.0
2	Massachusetts[3]	$83.8	$61.2	3.0
3	Vermont	$2.1	$56.4	3.0
4	Iowa	$40.5	$46.2	3.0
5	Utah	$36.1	$44.5	3.0
6	Wisconsin	$64.8	$39.1	3.0
7	Oregon[4]	$22.8	$33.7	2.5
8	California	$338.8	$32.2	2.5
9	New Jersey[5]	$83.0	$31.5	2.5
10	Minnesota	$40.1	$28.2	2.5
11	Connecticut	$11.5	$23.5	2.0
12	Rhode Island[6]	$4.8	$21.3	2.5
13	Maine	$0.4	$19.2	1.5
14	Colorado	$18.4	$11.3	1.0
15	New York[7]	$48.0	$11.1	1.0
16	District of Columbia	$1.5	$10.5	1.0
17	Florida	$6.5	$9.6	1.0
18	Indiana	$14.5	$8.7	1.0
19	Washington	$9.1	$8.6	1.0
20	South Dakota[8]	$1.4	$8.3	1.0
21	Delaware[9]	$1.2	$8.1	1.0
22	Michigan[10]	$25.0	$7.9	1.0
23	Arkansas	$4.2	$7.5	1.0
24	Idaho	$2.1	$6.1	0.5
25	Virginia	$6.2	$5.5	0.5
26	Missouri[11]	$7.1	$5.3	0.5
27	Kentucky[12]	$3.8	$5.1	0.5
28	Pennsylvania	$12.9	$4.9	0.5
29	New Mexico	$2.6	$4.6	0.5
30	Illinois	$17.3	$4.5	0.5
31	Nevada	$3.4	$4.5	0.5
32	Ohio	$11.0	$3.4	0.5
33	Maryland	$3.4	$3.2	0.5
34	Wyoming	$0.4	$2.6	0.5
35	Arizona	$2.6	$2.3	0.5
36	North Carolina	$1.3	$1.2	0.5
37	North Dakota	$0.1	$0.8	0.0
38	Georgia	$1.0	$0.6	0.0
39	Montana	$0.1	$0.4	0.0
40	Texas	$1.6	$0.4	0.0
40	Alabama	$0.0	$0.0	0.0
40	Alaska	$0.0	$0.0	0.0
40	Hawaii[13]	$0.0	$0.0	0.0
40	Kansas	$0.0	$0.0	0.0

Rank	State	2010 Program Budgets (Million $)[1]	Budgets Relative to Residential Customers ($ per customer)	Score
40	Louisiana	$0.0	$0.0	0.0
40	Mississippi	$0.0	$0.0	0.0
40	Nebraska	$0.0	$0.0	0.0
40	Oklahoma	$0.0	$0.0	0.0
40	South Carolina	$0.0	$0.0	0.0
40	Tennessee	$0.0	$0.0	0.0
40	West Virginia	$0.0	$0.0	0.0
	U.S. Total	**$941.6**	**$14.4**	

[1]Data are based on CEE (2010) unless otherwise noted; [2] NH PUC (2011); AEG (2011) [3] MA DOER (2011); [4] ETO (2011); [5]AEG 2011b; [6]RI PUC (2010c); [7]New York data based on CEE and NYSERDA (2011), [8] SD PUC (2011); [9]Delaware's Sustainable Energy Utility administers energy efficiency programs using RGGI funding and some state funding and had a budget of about $4.78 million in 2010. The budget is broken down to 75% for electricity programs and 25% to natural gas programs (DNREC 2011). [10] MI PSC (2010) [11] MO PSC (2011); [12] KY PSC (2011); [13] Hawaii does not have any natural gas providers.

Annual Savings in 2009 from Electricity Efficiency Programs

We measure the overall performance of electric energy-efficiency programs by the amount of electricity actually saved. Electricity savings are generated when a utility or third-party administrator offers an incentive or service program that helps ratepayers save energy in their home or business. Subject to internal or third-party evaluation, monitoring, and verification methodologies, the utility may claim credit for the energy savings the customer will realize. Utilities pursue numerous strategies to achieve energy efficiency savings. For utilities unaccustomed to energy efficiency, program portfolios may initially concentrate on the "lowest-hanging fruit"—generally the installation of lighting and appliances for residential and commercial customers. As utilities gain experience and customers become aware of energy efficiency benefits, program portfolio approaches multiply. States beginning to ramp up funding levels in response to aggressive Energy Efficiency Resource Standards, programs will necessarily shift focus from "widget-based" approaches (i.e. installing a new, efficient water heater) to "deep savings" approaches. "Deep savings" approaches seek new and innovative ways to generate more energy efficiency savings per program participant by conducting whole-building retrofits rather than installing one piece of equipment. "Deep savings" approaches may also include behavioral elements that empower customers with information on energy-use in conjunction with the emphasis on whole-building retrofits and comprehensive changes in both technologies and operations. Some deep savings approaches also extend to complementary programs, such as and building code enforcement programs.[21]

We score the states on annual incremental electricity savings (new savings achieved from measures implemented in the reporting year) in 2009 for electricity energy efficiency programs.[22] As our starting dataset we use EIA Form 861, which we supplement with further research that involves contacting all state utility commissions. States use different methodologies for determining program savings, and we acknowledge that this can produce some inequities when comparing states. A key difference in savings measurement involves how a state treats "free-riders"—savings attributed to programs that would have occurred absent the program, and "free-drivers"—savings not attributed to programs that would not have occurred without programs. We have tried our best to include "net" savings figures,

[21] See ACEEE's recent research report, *Energy Efficiency Resource Standards: Strategies for Higher Savings* (Nowak et al 2011) for a full discussion on this topic.
[22] While 2010 savings data is available in some states, it would be unfeasible to compare all 50 states on 2010 data due to significant gaps in reporting across and within the states. Readers should also note that programs that have been running for several years at a high level of funding are achieving the highest levels of *cumulative* electricity savings (total energy savings achieved to date from efficiency measures). *Incremental* savings data, however, are the best way to directly compare state efforts due to the difficulty in tracking the duration of programs and their savings.

which remove savings from "free-riders", rather than gross figures, which may overstate program performance. Absent a more consistent methodology across states, we must rely upon the states' most accurate reporting of energy saved due to programs. Important caveats to the data are noted in the footnotes beneath the table. Among them, a number of states do not have net savings figures available. In these cases, we have reported gross savings rather than applying a generic net-to-gross ratio. Gross savings has different definitions depending on the state. Because many states only reporting gross savings apply deemed savings methodologies that do take into account free-ridership, some gross figures are closer to net figures than others.

Scoring

Although it is an imperfect metric, realized energy efficiency savings is a critical component for the robust analysis of state energy efficiency performance. Statewide energy efficiency savings in 2009 are reported as a percent of retail electricity sales in that year and scored on a scale of 0 to 5.[23] States that achieved savings of at least 1.2% as a percent of electricity sales earn 5 points and score assignments are then distributed evenly among the ten scoring bins, dropping 0.5 points for every 0.12% of annual savings. Table 7 lists the scoring bins for each level of savings and Table 8 shows state-by-state results and scores for this category.

Table 7. Scoring Methodology for Utility and Public Benefits Electricity Savings

Percent Savings Range	Score
1.2% or greater	**5**
1.08% – 1.19%	**4.5**
0.96% – 1.07%	**4**
0.84% – 0.95%	**3.5**
0.72% – 0.83%	**3**
0.60% – 0.71%	**2.5**
0.48% – 0.59%	**2**
0.36% – 0.47%	**1.5**
0.24% – 0.35%	**1**
0.12% – 0.23%	**0.5**
Less than 0.12%	**0**

[23] Statewide electric sales data are drawn from (EIA 2011b).

Table 8. 2009 Incremental Electricity Savings by State

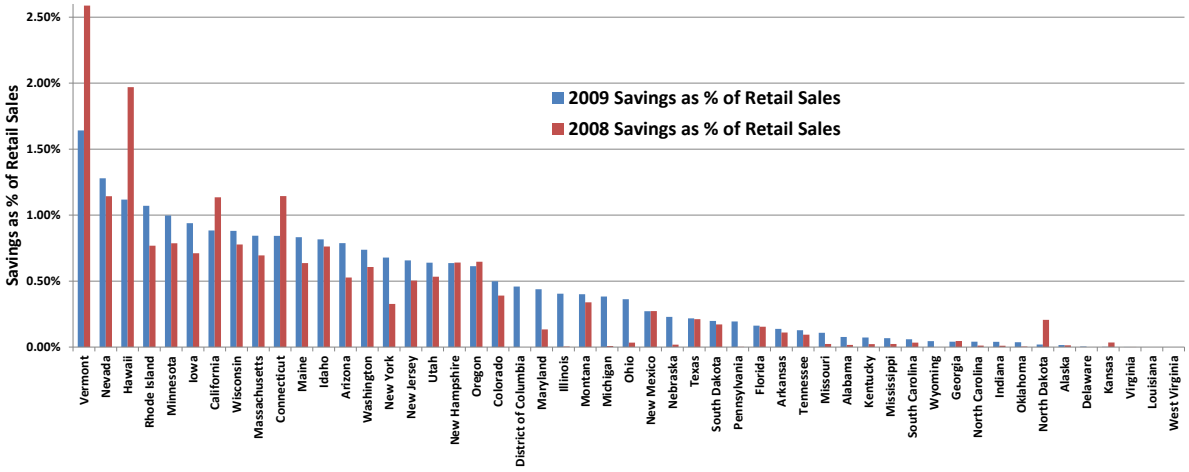
Rank	State	2009 Total Incremental Electricity Savings (MWh)	Savings as Percent of Electricity Sales	Score
1	Vermont[1]	90,235	1.64%	**5.0**
2	Nevada	438,622	1.28%	**5.0**
3	Hawaii[2]	113,159	1.12%	**4.5**
4	Rhode Island[3]	81,543	1.07%	**4.0**
5	Minnesota[4]	637,845*	1.00%	**4.0**
6	Iowa	409,735*	0.94%	**3.5**
7	California[5]	2,293,007	0.88%	**3.5**
8	Wisconsin[6]	583,506	0.88%	**3.5**
9	Massachusetts[7]	458,658	0.84%	**3.5**
10	Connecticut[8]	250,373	0.84%	**3.0**
11	Maine[9]	93,989	0.83%	**3.0**
12	Idaho[10]	185,684	0.82%	**3.0**
13	Arizona[11]	570,634	0.78%	**3.0**
14	Washington[12]	665,204	0.74%	**3.0**
15	New York[13]	949,575	0.68%	**2.5**
16	New Jersey[14]	497,479	0.66%	**2.5**
17	Utah[15]	176,505	0.64%	**2.5**
18	New Hampshire[16]	68,061*	0.64%	**2.5**
19	Oregon[17]	291,658	0.61%	**2.0**
20	Colorado[18]	254,588	0.50%	**2.0**
21	District of Columbia[19]	55,911	0.46%	**1.5**
22	Maryland[20]	274,239	0.44%	**1.5**
23	Illinois[21]	553,152	0.40%	**1.5**
24	Montana[22]	57,337	0.40%	**1.5**
25	Michigan[23]	375,652	0.38%	**1.5**
26	Ohio	530,062	0.36%	**1.5**
27	New Mexico[24]	58,916	0.27%	**1.0**
28	Nebraska	65,226	0.23%	**0.5**
29	Texas[25]	750,628	0.22%	**0.5**
30	South Dakota[26]	21,828	0.20%	**0.5**
31	Pennsylvania[27]	278,925*	0.19%	**0.5**
32	Florida	364,599	0.16%	**0.5**
33	Arkansas[28]	59,759*	0.14%	**0.5**
34	Tennessee[29]	120,769	0.13%	**0.5**
35	Missouri[30]	86,331	0.11%	**0.0**
36	Alabama[29]	63,382*	0.08%	**0.0**
37	Kentucky[29]	64,652	0.07%	**0.0**
38	Mississippi[29]	31,188	0.07%	**0.0**
39	South Carolina[31]	45,642*	0.06%	**0.0**
40	Wyoming[32]	7,400	0.04%	**0.0**
41	Georgia[29]	53,649	0.04%	**0.0**
42	North Carolina[29 31]	51,916*	0.04%	**0.0**
43	Indiana	39,903	0.04%	**0.0**

Rank	State	2009 Total Incremental Electricity Savings (MWh)	Savings as Percent of Electricity Sales	Score
44	Oklahoma	20,300	0.04%	**0.0**
45	North Dakota	2,530	0.02%	**0.0**
46	Alaska	965	0.02%	**0.0**
47	Delaware	490	0.00%	**0.0**
48	Kansas[33]	971	0.00%	**0.0**
49	Virginia[29]	1,029	0.00%	**0.0**
50	Louisiana	0	0.00%	**0.0**
50	West Virginia	0	0.00%	**0.0**
	U.S. Total	13,147,411	0.37%	

*Reported gross savings as net savings figures were unavailable
Notes: All savings data are as reported in EIA (2010a) unless noted otherwise below.

[1] VT PSB (2011); [2] Hawaii Energy (2010) Savings are for Program Year 2010; [3] RI PUC (2010b); [4] MN PUC (2011); [5] CPUC (2011); [6] Wisconsin utility savings from EIA and WI PSC; Focus on Energy savings from FOE [7] MA DOER (2011); [8] CT ECMB (2010); [9]EM (2010) Savings are for Program Year 2010; [10]Idaho savings from utility reports filed with Idaho Public Utilities Commission: Avista (2010), ID RMP (2010) , IDP (2010); [11] AZCC (2011); [12] Washington public utility savings from EIA; WA UTC (2011); [13] Savings data for New York are derived by combining utility savings data reported by EIA with the statewide program administrator's (NYSERDA) savings data (NYSERDA 2011b) [14] AEG (2011); [15] Rocky Mountain Power gross savings are adjusted to net savings using net to gross ratios presented in Appendix 1 of RMP (2010). [16] NH PUC (2011); [17] ACEEE estimate based on ETO (2011); [18] Savings for Public Service Colorado are from CO PSCo (2010). [19] DDOE (2011); [20] MD PSC (2011); [21] IL DCEO (2011); [22] Montana public utility savings from EIA, MT PSC (2011); [23] MI PSC (2010); [24] Xcel Energy (2011); NM PRC (2011); [25] Frontier Associates (2011); [26] SD PUC (2011); [27] PA PUC (2010); [28] Arkansas savings figures derived from Arkansas Public Service Commission Docket Nos. 08-038-RP, 08-039-RP, and 08-049-RP; [29] We add Tennessee Valley Authority (TVA) savings in these states (TVA 2011) to non-TVA program savings, which are based on EIA (2010a); [30] MO PSC (2011); [31] Duke Energy Carolinas savings apportioned out to North Carolina and South Carolina according to NC Docket E-7 Sub 979 and SC docket 2011-40-E. [32] SWEEP (2010) [33] Several Kansas utilities did reported spending but no savings to EIA and Kansas Corporation Commission; the savings figure presented here comes from KCC (2011).

Figure 4: Electric Energy Savings from Ratepayer-Funded Programs in 2008 and 2009[24]



Energy Savings Targets (Energy Efficiency Resource Standards)

Twenty-four states now have policies in place that establish specific energy savings targets that utilities or related organizations must meet through customer energy efficiency programs. These policies—called "energy efficiency resource standards" (EERS)—are analogous to "renewable portfolio standards," also in place in a majority of the states. An EERS sets multi-year electric or

[24] We have revised 2009 savings figures in Utah to reflect net, rather than gross savings.

natural gas efficiency targets (e.g., 2% incremental savings per year or 20% cumulative savings by 2020), presented as a percentage of retail sales.[25] Energy efficiency savings are typically measured by the first-year savings of energy-efficient measures installed. EERS policies accelerate and expand the scale of energy savings achieved through utility and related energy efficiency programs. This year, Arkansas was the only new state to adopt an EERS, while regulators in Florida and the state legislature in Wisconsin took actions to render their energy savings targets ineffective. Most states with EERS's in place are meeting current goals and on track to meet future goals.[26]

The widespread adoption of EERS policies represents a significant evolution in the treatment of energy efficiency in the utility system. The EERS has an explicit focus on quantifiable energy savings results, which directly reinforces the expectation that energy efficiency is a real utility system "resource," and helps utility system planners more clearly anticipate and project the effect of energy efficiency programs on utility system loads and resource needs. Moreover, EERS targets are generally set at levels that push programs to achieve higher savings than they would have targeted prior to enactment. EERS policies maintain strict requirements for cost-effectiveness so that programs are insured to provide overall benefits to customers. Not only does an EERS drive utilities and program administrators to achieve greater levels of savings, but it also helps ensure a long-term commitment to energy efficiency as a resource, building essential customer engagement as well as the workforce and market infrastructure necessary to sustain high savings levels.[27]

Key Distinctions of EERS Policies

EERS policies encompass three distinct types of policy approaches, all of which accomplish the same outcome—setting binding, long-term targets for energy efficiency savings from utility programs (Sciortino et al. 2011). The three approaches are a statewide Energy Efficiency Resource Standard, long-term energy savings targets set by utility commissions tailored to individual utilities or third-party administrators, and incorporating energy efficiency as an eligible resource in renewable portfolio standards (RPS). While the latter two options may not technically be considered a "standard" in the traditional sense, ACEEE has defined all three approaches as an EERS to avoid confusion and draw focus to the key similarity of all these policies—establishing binding, long-term energy savings targets. Certain states such as Massachusetts, Rhode Island, Washington, California, and others have a statewide EERS that operates in the following manner: (1) state law broadly requires utilities to procure all cost-effective efficiency resources ("an efficiency procurement requirement"); and (2) planning processes between the utilities, stakeholder efficiency councils, and public utility commissions (PUCs) then establish the specific percentage savings targets the utilities are required to meet to effectuate the all cost-effective efficiency procurement requirement. These states have set increasingly aggressive—and fully funded—efficiency savings targets.

[25] "Multi-year" is defined as three or more years. EERS policies may also set specific gigawatt-hour (GWh) energy savings targets without consideration of percentage of prior-year sales, or as a percentage of load growth.
[26] In Florida, cumulative energy savings targets of ~3.3% by 2019 remain in place for seven utilities (5 IOUs), but the Florida Public Service Commission approved program plans for Progress Energy and Florida Power & Light, which represent three-quarters of electric load in the state, that are certain to fall short of the targets. The other 5 utilities subject to targets are slated to meet their tailored utility targets.
[27] A recent ACEEE report, *Energy Efficiency Resource Standards: A Progress Report on State Experience,* analyzes current trends in EERS implementation and finds that most states are meeting or on track to meet energy savings targets (Sciortino et al 2011). Thirteen of the twenty states with EERS policies in place for over two years are achieving 100% or more of their goals, three states are achieving over 90% of their goals, and only three states are realizing savings below 80% of their goals. One state, North Carolina, has yet to hit its first target date.

Figure 5: Key Distinctions of EERS Policies

Statewide EERS	Tailored Utility Target	Combined EERS–RPS
Typically set by state legislatures and codified by utility commissions, the statewide EERS calls for all eligible utilities to achieve a prescribed level of savings. In efficiency procurement states, the state legislatures have required utilities to invest in all cost-effective efficiency and the specific targets are then set by stakeholder councils and PUCs.	Initiated in a variety of ways, long-term energy efficiency targets in these states are tailored to each specific utility or third-party administrator. In each case, law or regulation calls for the establishment of multi-year (3-year+) specific energy savings targets.	Energy efficiency may be accepted as an eligible resource in state renewable energy standards (RPS). In these cases, energy efficiency is measured on a cumulative, rather than annual, incremental basis.
Arizona, Arkansas, California, Illinois, Indiana, Massachusetts, Michigan, Minnesota, New Mexico, New York, Ohio, Pennsylvania, Texas	Colorado, Iowa, Maine, Oregon, Rhode Island, Vermont	Hawaii, Nevada, North Carolina

Scoring

A state can earn up to 4 points for an EERS policy based on a number of factors. The major considerations include target levels, whether the EERS covers electric and natural gas, and if the policy is binding. Some EERS policies contain "exit ramps" for utilities to avoid meeting the target or "cost caps" that limit a spending amount (e.g., Illinois). Table 9 explains the scoring methodology in detail. To directly compare the targets, we normalize savings targets to an estimated average annual savings target over the period that the target covers. For example, Arizona plans to achieve 22% cumulative savings by 2020, so the annual average target is 2.2%.

States with pending targets must be on a clear path towards establishing a binding mechanism to earn points in this category. Examples of a clear path include draft decisions by Commissions awaiting approval within six months, or agreements among major stakeholders on targets. States with a pending EERS policy that have not yet established a clear path toward implementation include Alaska, Oklahoma, New Hampshire, Utah, Delaware, and Virginia.[28] See Table 10 for scoring results and policy details.

Table 9. Scoring Methodology for Energy Savings Targets

Percent Savings Target or Current Level of Savings Met	Score
1.5% or greater	4
1% – 1.49%	3
0.5% – 0.99%	2
0.1% – 0.49%	1
Less than 0.1%	0

Other Considerations	Score
Cost cap inhibiting state from meeting targets	-1
Exit ramps	-0.5
EERS includes Natural Gas	+0.5

[28] Utah has both a legislative goal (House Joint Resolution 9) and a Renewable Portfolio Goal (S.B. 202) that includes energy efficiency savings targets. Neither of these goals has been codified into regulatory language by the Public Service Commission, so they remain advisory, not binding.

Table 10. State Scores for Energy Savings Targets

State Year Enacted Electric/Natural Gas Policy Type	Energy Efficiency Resource Standard	Approx. Annual Savings Target (Electric)	Binding Target or "Exit Ramp"	Reference	Score
Arizona 2009 Electric and Natural Gas EERS	Electric: 1.25% in 2011, ramping up to 2.5% annual savings beginning in 2015 through 2020. Cumulative savings of 22% by 2020. Natural Gas: 6% cumulative savings by 2020	2.2%	Binding	Docket Nos. RE-00000C-09-0427, Decision No. 71436	4
Hawaii[29] 2004 and 2009 Electric RPS - EERS and EERS	Renewable Portfolio Standards include 15% electrical energy savings through 2015. Starting in 2015 all electric utility savings will count towards Hawaii's Energy Efficiency Portfolio Standards (EEPS). EEPS long-term goal is 4,300 GWh reduction by 2030, or 30% of sales.	1.5%	Binding	HRS §269-91, 92, 96	4
Massachusetts[30] 2009 Electric and Natural Gas EERS	Electric: 2.0% in 2011; 2.4% in 2012 Natural Gas: 0.83% in 2011; 1.15% in 2012	2.4%	Binding	Electric: D.P.U. Order 09-116 through 09-120) Natural Gas: D.P.U. Order 09-121 through 09-128	4
Minnesota 2007 Electric and Natural Gas EERS	Electric: 1.5% annual savings beginning in 2010 Natural Gas: 0.75% annual savings from 2010-2012; 1.5% annual savings in 2013	1.5%	Binding	Minn. Stat. § 216B.241	4
New York 2008 Electric and Natural Gas EERS	Electric: 15% Cumulative savings by 2015 Natural Gas: ~14.7% Cumulative savings by 2020	1.9%	Binding	Electric: NY PSC Order, Case 07-M-0548 Natural Gas: NY PSC Order, Case 07-M-0748	4

[29] Although Hawaii does not currently have a mandated annual goal for energy efficiency, ACEEE estimates that the current 30% goal will result in 1.5% annual savings through utility programs.

[30] The underlying statute, Mass. General Laws c. 25 § 21, requires gas and electric efficiency program administrators to procure "all energy efficiency and demand reduction resources that are cost effective or less expensive than supply."

State Year Enacted Electric/Natural Gas Policy Type	Energy Efficiency Resource Standard	Approx. Annual Savings Target (Electric)	Binding Target or "Exit Ramp"	Reference	Score
Rhode Island 2006 Electric and Natural Gas Tailored Utility Targets	Electric: 1.5% in 2011; 1.7% in 2012, 2.1% in 2013, and 2.5% in 2014 Natural Gas: ~0.4% of sales in 2011; 0.6% in 2012, -0.8% in 2013, and 1.0% in 2014	2.0%	Binding	R.I.G.L § 39-1-27.7	**4**
Vermont 2000 Electric Tailored Utility Targets (Efficiency Vermont)	~6.75% cumulative savings from 2009 to 2011[31]	2.25%	Binding	30 V.S.A. § 209; VT PSB Docket 5980; 11-year Order of Appointment (Docket 7466)[32]	**4**
California[33] 2004 and 2009 Electric and Natural Gas EERS	Electric: ~1% annual savings through 2020 Natural Gas: 150 gross MMTh by 2012	1.0%	Binding	CPUC Decision 04-09-060; CPUC Decision 08-07-047; CPUC Decision 09-09-047	**3.5**
Illinois 2007 Electric and Natural Gas EERS	Electric: 0.8% annual savings in 2011, ramping up to 1% in 2012, 2% in 2015 and thereafter Natural Gas: 8.5% cumulative savings by 2020 (0.2% annual savings in 2011, ramping up to 1.5% in 2019)	1.7%	Cost Cap	S.B. 1918 Public Act 96-0033 § 220 ILCS 5/8-103	**3.5**

[31] Vermont Public Service has tentatively approved a 2012-2014 budget for Efficiency Vermont, which will achieve approximately 2.2% annual savings (VT Public Service Board Docket EEU-2010-06, Order Entered 8/1/2011).
[32] Goals for 2009 and 2010 were combined. Efficiency Vermont also set goals in previous years in three-year intervals.
[33] California's goals presented as gross savings. A rough estimate of California's goal as net savings can be achieved by converting gross savings to net savings using the 2009 net to gross conversion factor of 61% (CPUC 2011). Net goals are approximately 0.8% annual savings for the period 2010-2013, dropping to 0.55% from 2014-2020. California's evaluation and attribution methods are some of the strictest in the country, however, which partly explains the low net to gross conversion factor.

State Year Enacted Electric/Natural Gas Policy Type	Energy Efficiency Resource Standard	Approx. Annual Savings Target (Electric)	Binding Target or "Exit Ramp"	Reference	Score
Iowa 2009 Electric and Natural Gas Tailored Utility Targets	Electric: Varies by utility from 1-1.5% annually by 2013 Natural Gas: Varies by utility from 0.74-1.2% annually by 2013	1-1.5%	Binding	Senate Bill 2386 and Iowa Code § 476	**3.5**
Maryland[34] 2008 Electric EERS	15% per-capita electricity use reduction goal by 2015 with targeted reductions of 5% by 2011 calculated against a 2007 baseline (10% by utilities, 5% achieved independently)	1.5-1.8%	Binding (Utility portion only)	Md. Public Utility Companies Code § 7-211	**3.5**
Colorado 2007 Electric Tailored Utility Targets	Electric: PSCo and Black Hills Energy (BHE) both aim for 0.9% of sales in 2011 and increase to 1.35% (1.0% for BHE) of sales in 2015 and then 1.66% (1.2%) of sales in 2019	1-1.5%	Binding	Colorado Revised Statutes 40-3.2-101, et seq. ; COPUC Docket No. 08A-518E; Docket 10A-554EG	**3**
Indiana 2009 Electric EERS	0.5% annual savings in 2011, increasing to 1.1% in 2014, and leveling at 2% in 2019.	1.2% (avg. through 2019)	Binding	Cause No. 42693, Phase II Order	**3**
Maine 2010 Electric and Natural Gas Tailored Utility Targets (Efficiency Maine)	Electricity: Annual energy savings of ~1% in FY2011, ramping up to 1.4% in FY2013. Natural Gas: 130 BBtu annually by FY2013	1.25%	Cost Cap	Efficiency Maine Trust: Triennial Plan	**3**
Michigan 2008 Electric and Natural Gas EERS	Electric: 0.75% annual savings in 2011, 1% in 2012 and thereafter Natural Gas: 0.5% annual savings in 2011, 0.75% in 2012 and thereafter	1%	Cost Cap	M.G.L. ch. 25, § 21; Act 295 of 2008	**3**

[34] The 15% per-capita electricity use reduction goal translates to around 17% cumulative savings over 2007 retail sales.

State Year Enacted Electric/Natural Gas Policy Type	Energy Efficiency Resource Standard	Approx. Annual Savings Target (Electric)	Binding Target or "Exit Ramp"	Reference	Score
Washington 2006 Electric EERS	Biennial and Ten-Year Goals vary by utility. Law requires savings targets to be based on the Northwest Power Plan, which estimates potential savings of about 1.5% savings annually through 2030 for Washington utilities.	1-1.5%	Binding	Ballot Initiative I-937 WAC 480-109 WAC 194-37	**3**
Ohio 2008 Electric EERS	22% by 2025 (0.7% annual savings in 2011, ramping up to 1% in 2014 and 2% in 2019)	1.3% (avg. through 2025)	Exit Ramp	ORC 4928.66 et seq. S.B. 221	**2.5**
Arkansas 2010 Electric and Natural Gas EERS	Annual reduction of 0.25% of total electric kilowatt hour (kWh) sales to 0.75% of total electric kWh sales from 2011-2013 (slightly less for natural gas).	Approx. 0.5% (avg. through 2013)	Binding	Order No. 17, Docket No. 08-144-U; Order No. 15, Docket No. 08-137-U	**2**
Nevada 2005 and 2009 Electric RPS - EERS	20% Renewable energy by 2015 and 25% by 2025—energy efficiency may meet a quarter of the standard in any given year, or 5% cumulative savings by 2015 and 6.25% by 2025.	Up to 0.6% per year	Binding	NRS 704.7801 et seq.	**2**
Oregon 2010 Electric and Natural Gas Tailored Utility Targets (Energy Trust of Oregon)	Electric targets are equivalent to 0.8% of 2009 electric sales in 2010, ramping up to 1% in 2013 and 2014. Natural Gas: 0.2% of sales in 2010 ramping up to 0.4% in 2014	0.9% (avg. through 2014)	Exit Ramp	Energy Trust of Oregon 2009 Strategic Plan	**2**
Pennsylvania 2004 and 2008 Electric EERS	1% Cumulative savings by 2011, 3% by 2013	0.8% (avg. through 2013)	Cost Cap	66 Pa C.S. § 2806.1; PUC Order Docket No. M-2008-2069887	**2**

State Year Enacted Electric/Natural Gas Policy Type	Energy Efficiency Resource Standard	Approx. Annual Savings Target (Electric)	Binding Target or "Exit Ramp"	Reference	Score
New Mexico 2008 Electric EERS	5% reduction from 2005 total retail electricity sales by 2014, and a 10% reduction by 2020	0.7% (avg. through 2020)	Exit Ramp	N.M. Stat. § 62-17-1 et seq.	**1.5**
North Carolina 2007 Electric RPS - EEERS	Renewable Energy and Energy Efficiency Portfolio Standard (REPS). Investor-owned: 12.5% by 2021 and thereafter. Energy efficiency is capped at 25% of the 2012-2018 targets and at 40% of the 2021 target.	Up to 0.25% in 2012; no specific EE goal	Cost Cap	N.C. Gen. Stat. § 62-133.8 04 NCAC 11 R08-64, et seq.	**1**
Texas 1999 and 2007 Electric EERS	20% Incremental Load Growth in 2011 (equivalent to ~0.10% annual savings); 25% in 2012, 30% in 2013+[35]	Approx. 0.40%	Cost Cap	Senate Bill 7; House Bill 3693; Substantive Rule § 25.181	**1**

[35] In the 2011 legislative session, Texas adopted Senate Bill 1125, which amends the EERS policy by requiring utilities to achieve savings of 0.4% of each company's annual load beginning in 2013. As a result, utilities with declining or rapidly growing load growth will have more predictable and consistent goals than those that were set based on load growth. The Bill also added focus on reducing demand in the winter, which is more likely to result in real energy efficiency savings than summer demand response programs, which simply shift load and reduce peak demand. The actual demand response goals will likely be based on summer demand. The Bill does not remove the cost caps adopted in 2010.

Financial Incentives Affecting Utility Investment in Efficiency: Earning a Return and Addressing Lost Revenues

Under traditional regulatory structures, utilities do not have an economic incentive to help their customers become more energy efficient. In fact, they typically have a disincentive because falling energy sales from energy efficiency programs reduce utilities' revenues and profits, an effect that is sometimes referred to as "lost revenues" or "lost sales." Since utilities' earnings are usually based on the total amount of capital invested in selected asset categories (such as transmission lines and power plants) and the amount of electricity sold (kilowatt-hours), the financial incentives are very much tilted in favor of increased electricity sales and expanding supply-side systems.

Understanding this dynamic has led industry experts to devise ways of addressing possible earnings and profit losses that can result from customer energy efficiency programs while removing the disincentive to promote energy efficiency among utilities' customers. There are three key policy approaches to address the removal of disincentives and the implementation of positive incentives for reducing customer energy use through improved energy efficiency. The first of these policy mechanisms is to ensure recovery of the direct costs associated with energy efficiency programs. This is a minimum threshold requirement for utilities and related organizations to fund and offer energy efficiency programs. We do not address such basic program cost recovery in our *Scorecard*.

The other two mechanisms are fixed cost recovery (decoupling and other lost revenue adjustment mechanisms) and shareholder incentives. Decoupling refers to the disassociation of a utility's revenues from sales, which makes the utility indifferent to losses or increases in sales. Although this does not necessarily make the utility more likely to promote efficiency programs, it removes the disincentive for them to do so. Additional mechanisms for addressing lost revenues include modifications to rates that permit utilities to collect the revenues “lost” either through a lost revenue adjustment mechanism (LRAM) or other ratemaking approach. Shareholder incentives are financial incentives that reward utilities (and in some cases, non-utility organizations) for reaching or exceeding specified program goals. ACEEE views decoupling as the preferred approach to properly align utility incentives, and sees LRAM as a second-best approach to addressing similar challenges. Similarly, ACEEE recommends a shareholder incentive that is awarded based on achievement of actual energy savings targets, as opposed to spending goals. These mechanisms have received a great deal of attention recently with a number of states enacting them in order to support increased energy efficiency initiatives and programs. While this section captures enabling policies, other sections of this chapter capture the performance and scale of utility energy efficiency programs.

Scoring

For this category, a state can earn up to 3 points for having adopted financial incentive mechanisms for utility electric and natural gas efficiency programs and for having implemented decoupling for addressing lost revenues for its electric and natural gas utilities (see Table 11). States with at least one major utility program were given credit. Information about individual state decoupling policies and financial incentive mechanisms is available on ACEEE’s State Energy Efficiency Policy Database[36] and in Appendix D.

The scoring methodology changed slightly from last year to include states with ratemaking approaches for recovering lost revenues that are not traditional decoupling or LRAM approaches. Additionally, we attempted to simplify the scoring criteria by splitting the 3 points for lost revenues and incentives into two 1.5 point blocks to clearly illustrate to readers which states have policies in place or pending and whether they apply to electric or natural gas utilities. As decoupling is a preferred method for addressing the issue of lost revenues this approach is weighted more favorably than an

[36] See http://www.aceee.org/sector/state-policy

LRAM or ratemaking approach.[37] Details describing the scoring methodology are provided in Table 11.

Table 11. States Scoring Methodology for Utility Financial Incentives

Scoring Criteria for Addressing "Lost Revenues"	Points
Decoupling has been established for both electric and natural gas utilities for at least one major utility.	1.5
Decoupling established for either electric or natural gas utilities for at least one major utility. LRAM or ratemaking approach for recovery of lost revenues established for both electric and natural gas utilities for at least one major utility.	1
The legislature or regulatory commission has authorized or recommended decoupling, but it has not yet been implemented. LRAM or ratemaking approach for recovery of lost revenues established for **either** electric **or** natural gas utilities for at least one major utility.	0.5
Scoring Criteria for Addressing "Shareholder Incentives"	**Points**
Shareholder incentives established for both electric and natural gas utilities for at least one major utility (or non-utility organizations).	1.5
Shareholder incentives established for at least one electric or natural gas utility or non-utility organization.	1
The legislature or regulatory commission has authorized or recommended shareholder incentive but the use of a given mechanism has not yet been implemented.	0.5

Table 12. Utility Efforts to Address Lost Revenues and Financial Incentives

	Decoupling (or Related Mechanism)		Performance Incentives		
State	Electricity	Natural Gas	Electricity	Natural Gas	Score
California	Yes	Yes	Yes	Yes	3
Massachusetts	Yes	Yes	Yes	Yes	3
Michigan	Yes	Yes	Yes	Yes	3
New York	Yes	Yes	Yes	Yes	3
Rhode Island	Yes	Yes	Yes	Yes	3
Alabama	Yes^	Yes^	Yes	Yes	2.5
Colorado	Yes^	Yes	Yes	Yes	2.5
Indiana	Yes^	Yes	Yes	Yes	2.5
Kentucky	Yes^	Yes^	Yes	Yes	2.5
Louisiana	Yes^	Yes^	Yes	Yes	2.5
South Dakota	Yes^	Yes^	Yes	Yes	2.5
Wisconsin	Yes	Yes^	Yes	Yes	2.5
District of Columbia	Yes	No	Yes	Yes	2.5
Minnesota	Yes*	Yes	Yes	Yes	2.5

[37] Hayes S., S. Nadel, M. Kushler, D. York. September 2011. Balancing Interests: A Review of Lost Revenue Adjustment Mechanisms for Utility Energy Efficiency Programs. Washington, D.C.: ACEEE.

	Decoupling (or Related Mechanism)		Performance Incentives		
State	Electricity	Natural Gas	Electricity	Natural Gas	Score
North Carolina	Yes~	Yes	Yes	No	2.5
Connecticut	Yes~	Yes^	Yes	No	2
Hawaii	Yes	No	Yes	No	2
Ohio	Yes^	Yes^	Yes	Yes*	2
Maryland	Yes	Yes	Yes*	Yes*	2
New Hampshire	Yes*	Yes*	Yes	Yes	2
Vermont	Yes	Yes^	Yes	No	2
Arkansas	Yes^	Yes^	Yes*	Yes*	1.5
Georgia	Yes^	No	Yes	No	1.5
Montana	Yes^	Yes^	Yes*	Yes*	1.5
Nevada	Yes^	Yes	Yes*	No	1.5
Oklahoma	Yes^	No	Yes	No	1.5
South Carolina	Yes^	No	Yes	No	1.5
Arizona	Yes^*	Yes*	Yes	No	1.5
Oregon	Yes	Yes	No	No	1.5
Utah	Yes*	Yes	Yes*	Yes*	1.5
Virginia	Yes^*	Yes	Yes*	No	1.5
Washington	Yes*	Yes~	Yes*	Yes*	1.5
Missouri	Yes^*	Yes^	Yes*	Yes*	1
Florida	Yes^*	Yes*	Yes*	Yes*	1
Idaho	Yes	No	No	No	1
Illinois	No	Yes	No	No	1
Kansas	Yes^	Yes*	Yes*	Yes*	1
Maine	Yes*	Yes*	Yes*	Yes*	1
Texas	No	No	Yes	No	1
Delaware	Yes*	Yes	No	No	1
Wyoming	Yes^	Yes	No	No	1
New Jersey	Yes^*	Yes^	No	No	0.5
New Mexico	Yes^*	Yes^*	Yes*	Yes*	0.5
Tennessee	No	Yes^	No	No	0.5
Iowa	No	Yes*	No	No	0.5
Alaska	No	No	No	No	0
Mississippi	No	No	No	No	0
Nebraska	No	No	No	No	0
North Dakota	No	No	No	No	0
Pennsylvania	No	No	No	No	0
West Virginia	No	No	No	No	0

* Decoupling for electric or gas utilities, or both, or performance incentives are authorized according to legislation or commission order but are not yet implemented.
^ No decoupling, but some other mechanism for lost revenue adjustment.
~ Both decoupling and some other mechanism for lost revenue adjustment.

Figure 3. Leading States: Utility and Public Benefits Programs and Policies

California: California utilities have implemented energy efficiency programs for decades, achieving substantial savings thanks to significant regulatory and budget support from the California Public Utilities Commission (CPUC). The state implemented decoupling in 1982 for its three electric investor-owned utilities, which has played a major role in the state's success with energy efficiency. California invests about $1 billion per year in energy efficiency to achieve consistently impressive levels of cost-effective energy savings. California public- and investor-owned utilities are national leaders in energy efficiency program implementation, consistently achieving savings around 1% of sales annually.

Massachusetts: Massachusetts has a long record of success implementing energy efficiency programs, which are managed and implemented by electric and natural gas distributors. The state took a major leap forward in 2008, however, when it passed the Green Communities Act (GCA), which established energy efficiency as the state's "first-priority" resource, creating an Energy Efficiency Advisory Council to collaborate with utilities to develop statewide efficiency plans in three-year cycles. The three-year plan in operation aims to achieve electric savings equal to 2.4% and natural gas savings equal to 1.5% of sales in 2012, which amounts to the most aggressive EERS target in the nation. The GCA is ultimately expected to lead to an investment of $2.2 billion in energy efficiency and demand resources between 2010 and 2012.

Minnesota: Minnesota's investor- and publicly-owned utilities offer broad portfolios of energy efficiency programs, which have benefitted from consistent and strong regulatory support, allowing them to evolve and improve for many years. The state has long encouraged energy efficiency by allowing utilities to earn an incentive for successful energy efficiency program performance. Not content to rest on its laurels, the state enacted the Next Generation Act in 2007, which set aggressive energy-saving goals for utilities equal to 1.5% of sales each year, raising the bar for program performance. The impact of the EERS is becoming evident in the steadily increasing savings figures in the state.

Rhode Island: Building on its strong program history, Rhode Island leapt forward with the Comprehensive Energy Conservation and Affordability Act of 2006, which established energy efficiency as the state's first-priority resource and set the framework for major investments in energy efficiency programs. Similar to Massachusetts, the state's major utility collaborates with an expert council to develop three-year plans with savings and budget goals. In its latest plan, approved for 2012-2014, the state seeks to reach 2.5% annual electric savings and 1.2% annual natural gas savings in 2014.

Vermont: Vermont pioneered the third-party administration model of energy efficiency program implementation, which has been replicated in states such as Maine, New Jersey, D.C., Delaware, and Oregon. Efficiency Vermont, the state's "energy efficiency utility", runs energy efficiency programs for a wide range of customers and leads the nation in producing energy savings. Vermont's excellent performance is due in large part to a strategic commitment by the Vermont Public Service Board (PSB) to fund programs at aggressive levels to reach new customers and achieve deep savings. The PSB has also put in place the proper mix of policies, including energy savings targets (EERS) and performance incentives to encourage successful programs.

CHAPTER 2: TRANSPORTATION POLICIES

Author: Shruti Vaidyanathan

The transportation energy efficiency score is based on a review of state actions that go beyond federal policies to achieve a more energy-efficient transportation sector. These may be actions to improve the efficiency of vehicles purchased or operated in the state, policies to increase the use of more efficient modes of transportation, or the integration of land use and transportation planning so as to reduce the need to drive.

At the federal level, major progress has been made recently in reducing car and truck fuel consumption. Federal Corporate Average Fuel Economy (CAFE) standards adopted in April, 2010 require a fleet fuel economy of 34.1 mpg by 2016. The U.S. Environmental Protection Agency (EPA) adopted companion greenhouse gas emissions standards for vehicles, matching the stringency of California's vehicle greenhouse gas (GHG) emissions requirements. EPA and the U.S. Department of Transportation are now developing fuel economy and GHG standards for model years 2017 to 2025; a final rule is expected in mid-2012. California is working in tandem with the federal agencies to update its tailpipe GHG standards and continues to be a major force in pushing the national standards to the highest cost-effective level. For this reason, we awarded states that have adopted the California GHG tailpipe emissions standard 2 points. In addition, states offering consumer incentives for the purchase of high-efficiency vehicles earned one point.

In the category of actions to promote non-auto modes of transportation, this year we award a point to states that have adopted "complete streets" laws that ensure proper attention to the needs of pedestrians and cyclists in all road projects. States with relatively high investment in transit ($50 per capita or more) also receive a point.

Because policies to promote compact development and ensure accessibility of major destinations are essential to reduce transportation energy use in the long term, states that have adopted coordinated land use and transportation policies can score up to 2 points. Those adopting targets for vehicle miles traveled statewide are also eligible for 2 points.

Table 13. Results from ACEEE's 2011 Scorecard: State Scoring on Transportation Policies

State	GHG Tailpipe Emissions Standards[a]	Integration of Transportation and Land Use Planning[b]	VMT Targets	Complete Streets Legislation[c]	Transit Funding[d]	High-Efficiency Vehicle Consumer Incentives[e]	Score
Maximum Score	***2***	***2***	***2***	***1***	***1***	***1***	***9***
California	2	1	2	1	1	1	**8**
Maryland	2	2	0	1	1	1	**7**
Massachusetts	2	1	2	1	1	0	**7**
Washington	2	1	2	0	0	1	**6**
Connecticut	2	2	0	1	1	0	**6**
New York	2	1	2	1	0	0	**6**
Oregon	2	1	1	0	1	1	**6**
New Jersey	2	2	0	1	0	0	**5**
Rhode Island	2	2	0	0	1	0	**5**
Florida	2	2	0	0	1	0	**5**
Arizona	2	2	0	0	0	0	**4**
District of Columbia	2	0	0	1	0	1	**4**
Maine	2	2	0	0	0	0	**4**

State	GHG Tailpipe Emissions Standards[a]	Integration of Transportation and Land Use Planning[b]	VMT Targets	Complete Streets Legislation[c]	Transit Funding[d]	High-Efficiency Vehicle Consumer Incentives[e]	Score
Pennsylvania	2	1	0	1	0	0	**4**
Vermont	2	1	0	0	1	0	**4**
Tennessee	0	2	0	0	1	1	**4**
Delaware	0	2	0	1	0	0	**3**
Hawaii	0	1	0	0	1	1	**3**
Illinois	0	1	0	0	1	1	**3**
New Mexico	2	0	0	0	0	0	**2**
Colorado	0	0	0	0	1	1	**2**
Georgia	0	1	0	0	0	1	**2**
Minnesota	0	0	0	1	1	0	**2**
Michigan	0	1	0	0	1	0	**2**
Alaska	0	0	0	1	0	0	**1**
Oklahoma	0	0	0	0	0	1	**1**
Virginia	0	1	0	0	0	0	**1**
Wisconsin	0	0	0	0	1	0	**1**
Utah	0	0	0	0	0	1	**1**
Iowa	0	1	0	0	0	0	**1**
Louisiana	0	0	0	0	0	1	**1**
North Dakota	0	1	0	0	0	0	**1**
West Virginia	0	0	0	0	0	1	**1**
South Carolina	0	0	0	0	0	0	**0**
Alabama	0	0	0	0	0	0	**0**
Arkansas	0	0	0	0	0	0	**0**
Idaho	0	0	0	0	0	0	**0**
Indiana	0	0	0	0	0	0	**0**
Kansas	0	0	0	0	0	0	**0**
Kentucky	0	0	0	0	0	0	**0**
Mississippi	0	0	0	0	0	0	**0**
Missouri	0	0	0	0	0	0	**0**
Montana	0	0	0	0	0	0	**0**
Nebraska	0	0	0	0	0	0	**0**
Nevada	0	0	0	0	0	0	**0**
New Hampshire	0	0	0	0	0	0	**0**
North Carolina	0	0	0	0	0	0	**0**
Ohio	0	0	0	0	0	0	**0**
South Dakota	0	0	0	0	0	0	**0**
Texas	0	0	0	0	0	0	**0**
Wyoming	0	0	0	0	0	0	**0**

[a] Source: Clean Cars Campaign
[b] Source: rankings based on criteria in NRDC (2011)
[c] Source: NCSC (2010)
[d] Source: AASHTO (2010), See Appendix C for a complete ranking of state transit funding.
[e] Source: EERE Alternative Fuel and Advanced Vehicles Data Center

Tailpipe Emission Standards

Vehicles' greenhouse gas (GHG) emissions are largely proportional to their fuel use. In 2002, California passed the Pavley Bill (AB1493), the first U.S. law to address GHG emissions from vehicles. The law required the California Air Resource Board (CARB) to regulate GHG as part of the California Motor Vehicle Program. In 2004, CARB adopted a rule requiring automakers to begin in the 2009 model year (MY) to phase in lower-emitting cars and trucks that will collectively emit 22% fewer greenhouse gases than 2002 vehicles in MY 2012 and 30% fewer in MY 2016. Fourteen states have adopted California's GHG regulations (see Table 14).

The GHG reductions will mainly be achieved through improved vehicle efficiency, so these standards are, to a large degree, energy efficiency policies. Several technologies stand out as providing significant, cost-effective reductions in emissions. Among others, these include the turbocharged engines with direct injection, optimization of valve operation, improved multi-speed transmissions, use of high-strength, lightweight materials, and improved air conditioning systems.

In April 2010, the EPA and the U.S. Department of Transportation (DOT) issued harmonized national standards for fuel economy and greenhouse gas emissions for model years 2012 to 2016. These standards match California's GHG tailpipe standards in stringency and call for a fleet-wide average fuel economy of 34.1 miles per gallon by 2016. States may choose to adopt either the federal vehicle standards or California's.

California has been the leader in clean vehicle standards for decades, pushing the federal government to upgrade standards for both criteria pollutant emissions and GHG emissions from vehicles. Their success in this role is due in part to auto manufacturers' preference for minimizing the number of distinct regulatory regimes for vehicles. DOT and EPA are currently developing fuel economy and greenhouse gas standards for model years 2017 to 2025, and California is once again instrumental in promoting the adoption of the highest feasible efficiency standards. In light of the role of California's standards, adopting states are awarded two points in the transportation energy efficiency scoring.

Table 14. States that Have Adopted California's Tailpipe Emission Standards

State
California
Arizona
Connecticut
District of Columbia
Florida
Massachusetts
Maine
Maryland
New Jersey
New Mexico
New York
Oregon
Pennsylvania
Rhode Island
Vermont
Washington

Source: www.cleancarscampaign.org

Despite the potential energy saving benefits of the California Clean Car program, recent efforts have been made in certain states to repeal the adoption of these more stringent standards. The Arizona Department of Environmental Quality (ADEQ) submitted a proposal in March, 2011 to overturn the program that was adopted in 2008 on the basis that the program is too costly to implement in Arizona

and that the federal standards passed in 2010 are nearly as strict as the California rule. A public hearing on the proposal was held in June and the ADEQ expects to make a decision later this year.

Incentives for High-Efficiency Vehicles

The high cost of advanced technology, fuel-efficient vehicles is a key barrier to their entry into the market place. To encourage consumers to purchase these vehicles, states offer a number of financial incentives, including tax credits, rebates, and sales tax exemptions. Several states offer tax incentives to individual purchasers of alternative-fuel vehicles (AFVs), which typically include vehicles that run on compressed natural gas (CNG), ethanol, propane, or electricity, and in some cases hybrid vehicles (electric or hydraulic). While AFVs can provide substantial environmental benefits by reducing pollution, they do not generally improve vehicle fuel efficiency, and policies to promote their purchase therefore are not necessarily included in our scorecard. However, electric vehicles and hybrids typically do have high fuel efficiency, so incentives for purchase of these vehicles in particular are eligible for one point.[38] With the arrival of the Chevrolet Volt plug-in hybrid sedan and the Nissan Leaf all-electric vehicle, tax credits for electric vehicles are playing an important role in spurring the adoption of high-tech vehicles. States with purchase incentives framed in terms of fuel economy are also awarded a point. Table 15 below outlines the consumer incentives available by state.

A state feebate policy that provides a rebate or charges a fee for the purchase of a vehicle, depending on its fuel efficiency, would also receive credit in our scoring of transportation policies. However, although several states have considered feebates, none have such a policy in place as yet. Incentives for the use of High Occupancy Vehicle (HOV) lanes and preferred parking programs for high efficiency vehicles are not included in our consideration of a state's transportation score, as they may promote driving and consequently bring no net energy benefit.

Table 15. State Purchase Incentives for High-Efficiency Vehicles

State	Tax Incentive
California	AB 118 funds a voucher program, targeted at medium- and heavy-duty trucks, whose goal is to reduce the upfront incremental cost of purchasing a hybrid vehicle. Vouchers range from $20,000 to $40,000, depending on vehicle specifications, and will be paid directly to fleets that purchase hybrid trucks for use within the state. California also offers tax rebates of up to $5,000 for light-duty zero emission electric vehicles and plug-in hybrid electric vehicles on a first come, first serve basis from March 15th, 2010 onwards.
Colorado	In 2009, Colorado extended financial incentives available for purchasers of high-efficiency vehicles out to 2015. Consumers can claim up to $6,000 for the purchase of a plug-in or hybrid vehicle. Individuals that convert a personal vehicle to plug-in hybrid technology can claim up to $7,500.
District of Columbia	The DMV Reform Amendment act of 2004 exempts owners of hybrid electric and electric vehicles from vehicle excise tax and reduces the vehicle registration charge.
Georgia	Purchasers of electric vehicles may qualify for a tax credit equivalent to 10% of the cost of a new vehicle, up to $2,500.
Hawaii	Hawaii's EV Ready Rebate Program provides residents, businesses, government and non-profit agencies with rebates for the purchase of electric vehicles amounting to 20% of the vehicle purchase price, up to $4,500. The program expires on September 30, 2011.
Illinois	Residents of Illinois may claim a rebate for 80% of the incremental

[38] Several early hybrids provided little fuel economy benefit, because the technology was used to increase vehicle power rather than to improve fuel economy. These hybrids did not sell well and have mostly been discontinued, but this issue remains a concern for hybrid incentive programs.

State	Tax Incentive
	cost of purchasing an electric vehicle (up to $4,000) as part of the Illinois Alternative Fuels Rebate Program.
Louisiana	Louisiana offers an income of tax credit equivalent to 50% of the incremental cost of purchasing an electric vehicle under the state's alternative fuel vehicle tax credit program. Alternatively, taxpayers may claim the lesser of 10% of the total cost of the vehicle or $3,000.
Maryland	Purchasers of qualifying all electric and plug-in hybrid electric light-duty vehicles may claim up to $2,000 against the vehicle excise tax in the state of Maryland. Vehicles must meet certain speed, weight and motor requirements to qualify for the program.
Oklahoma	A one-time tax credit for 50% of the incremental cost of purchasing an electric vehicle is available to residents in Oklahoma. The state will provide a tax credit equivalent to 10% of the total purchase price of an electric vehicle (up to $1,500) if the incremental cost of the vehicle cannot be determined. The program expires January 1st, 2015.
Oregon	Oregon residents can claim up to $1,500 in tax credits for the purchase of an HEV or electric vehicle. A tax credit for business owners is also available for the purchase of HEVs and electric vehicles. The tax credit is 35% of the incremental cost of the system or equipment and is taken over five years.
Tennessee	The first 1,000 electric vehicles purchased in the state of Tennessee qualify for a $2,500 rebate from the Tennessee Department of Revenue.
Utah	Prior to December 31st, 2013, electric vehicles qualify for a tax credit equivalent to the lesser of 35% of the vehicle purchase or $2,500.
Washington	Effective from January 2009 through January 2011, the state use tax and retail sales tax do not apply to sales of new passenger cars, light duty trucks, and medium duty passenger vehicles that utilize hybrid technology and have an EPA-estimated highway gasoline mileage rating of at least 40 miles per gallon. Electric vehicles are also exempt from the state sales tax.
West Virginia	Starting on July 1st, 2011, residents of West Virginia are eligible for a tax credit equivalent to 35% of the purchase price of an electric vehicle. Up to $7,500 is available for vehicles that have a Gross Vehicle Weight Rating (GWVR) up to 26,000 lbs. , and as much as $25,000 is available for vehicles having GVWR greater than 26,000 lbs.

Source: DOE (2011b)

State Transit Funding

While states receive some federal funds for public transit, they provide most transit funding from their own budgets. A state's investment in public transit is a key indicator of its interest in promoting energy-efficient modes of transportation, although realizing the potential for energy savings through transit typically requires land use planning changes as well. States that spent a combined $50 or more per capita on public transit in FY 2008 earned one point in the overall transportation scorecard.[39]

[39] See Appendix C for a full table of state transit spending per-capita. We use FY 2008 figures as they are the latest available data for all 50 states and the District of Columbia.

These are: Massachusetts, New York, Maryland, Alaska, New Jersey, Delaware, Pennsylvania, District of Columbia, Connecticut, Minnesota and California.

VMT Reduction Targets

Raising fuel economy and emissions standards will not adequately address transportation sector energy use in the long term if growth in total vehicle miles traveled goes unchecked. U.S. highway VMT is projected to grow 36% by 2030, substantially outpacing population growth in the country (EIA 2011c).Reducing the rate of VMT growth requires the coordination of transportation and land use planning, and state and local governments play more important roles than the federal government does.

Codified VMT reduction targets are an important step towards achieving substantial reductions in VMT. States that have specific targets earn 2 points. Thus far, only three states score the full two points: California, Washington and New York. Oregon is in the process of adopting specific VMT reduction goals and, therefore, earns 1 point.

Integration of Land Use and Transportation Planning Policies

Sound land use planning is vital in order to stem growth in vehicle miles travelled in the United States. Successful strategies for changing land use patterns to reduce the need to drive vary widely among states due to current infrastructure, geography and political structure. However, core principles of smart growth should be embodied in state comprehensive plans. Energy-efficient transportation is inherently tied to the integration of transportation and land use policies, and an approach to planning that successfully addresses land use and transportation considerations simultaneously is critical to state-wide VMT reductions. This approach includes measures that encourage the creation of:

- Transit-oriented development (TOD), including mixed land uses (mix of jobs, stores, and housing) and good street connectivity that makes neighborhoods pedestrian-friendly;
- Areas of compact development;
- Convenient alternative modes of transportation; and
- Activity centers where destinations are close together.

States can earn a maximum of 2 points for the adoption of integrated land use and transportation policies. States with codified growth management acts score 1 point, as do those with smart growth statutes.

Complete Streets Policies

Equally vital to the discussion about land use planning and VMT reduction is the concept of “complete streets.” Complete streets policies focus on the interconnectivity of streets and target safe and easy access to roads by all pedestrians, bicyclists, motorists and public transportation users. States that implement complete streets legislation essentially mandate their transportation agencies to evaluate and incorporate complete streets principles. Transportation planners are tasked with ensuring that all roadway and highway infrastructure projects allow for equitable access and use of those roadways. States that have codified complete streets legislation earn 1 point in our rankings.

Figure 7. Leading States: Transportation Policies

California: As part of its plans to implement AB 32, which requires a 25% reduction from 1990 levels in greenhouse gas emissions by 2020, California has identified several smart growth and VMT reduction strategies. In 2008, the state passed SB 375, which requires the Air Resources Board (ARB) to develop regional transportation-specific greenhouse gas reduction goals, in collaboration with Metropolitan Planning Organizations. These goals must subsequently be reflected by regional transportation plans that create compact, sustainable development across the state and thus reduce VMT growth. ARB released draft targets in June 2010 that recommend a 5–10% reduction in vehicle greenhouse gas emissions by 2020 for the four largest Metropolitan Planning Organizations in the state (ARB 2010a).

California also passed AB 118 in 2009, a clean transportation program that includes funding for a hybrid vehicle rebate program targeted at medium- and heavy-duty vehicles. The goal of the Hybrid Truck and Bus Voucher Incentive Project (HVIP) is to reduce the high upfront costs associated with the purchase of high-efficiency vehicles. The program is currently in its second year. Rebates range from $20,000 to $40,000 per vehicle depending on vehicle specification. California also offers tax rebates of up to $5,000 for light-duty zero emission electric vehicles and plug-in hybrid electric vehicles.

Maryland: Maryland has long been a leader in the implementation of transportation policies. In 1992, the state passed the Economic Growth, Resource Protection and Planning Act as a means to coordinate planning priorities amongst state, regional and municipal government. The act mandates the consideration of conservation practices and transportation in the creation of comprehensive plans.

Maryland's Smart Growth program, initiated in 1997, aims to promote development near transit hubs and other centers of activity. Policies to encourage this development include focusing state spending on existing centers and areas designated for growth, limiting road expansion in favor of public transit and promoting urban redevelopment. In 2001, Maryland state general assembly dedicated $500 million to the upgrade of mass transit service and infrastructure.

Additional transportation policies include the adoption of a tax credit to encourage the deployment of plug-in hybrid and electric vehicles, as well as codification of a complete streets policy to ensure equal access to transportation facilities by all vehicular modes.

***Massachusetts*:** In recent years, Massachusetts has taken several significant steps to improve transportation efficiency within the state. The state's 40-R program, the Smart Growth Zoning Law, provides financial incentives for municipalities to increase density and build affordable housing in areas with good access to transit. The Commonwealth Capital program, initiated in 2005, applies several smart growth criteria to municipalities' applications for state funding.

In 2009, the state implemented language from Chapter 90E, mandating the accommodation of biking and pedestrian traffic in future transportation construction plans. This was quickly followed in 2010 by the GreenDOT directive, which calls on the Department of Transportation (DOT) to reduce in-state transportation greenhouse gasses by 7.3% by 2020 and 12.3% by 2035 from 1990 levels. To achieve these reductions in GHG, DOT will promote alternative modes of transport and support smart growth developments to reduce automobile travel within the state in addition to creating travel demand management programs and providing incentives for efficient fleets and eco-driving.

CHAPTER 3: BUILDING ENERGY CODES

Author: Max Neubauer

Background

Buildings consume 73% of electricity use and 40% of total energy use in the United States, while accounting for 40% of U.S. carbon dioxide emissions (DOE 2008). This makes buildings an essential target for energy savings. However, because buildings have long lifetimes and are not easily retrofitted, it is crucial to target building efficiency measures prior to completing construction. Mandatory building energy codes are one way to target energy efficiency by requiring a minimum level of energy efficiency for new residential and commercial buildings.

In 1978, California enacted the first statewide building energy code in its Title 24 Building Standard. Several states (including Florida, New York, Minnesota, Oregon, and Washington) followed with state-developed codes in the 1980s. During the 1980s and 1990s, the International Code Council (ICC) and its predecessor developed its Model Energy Code (MEC), which was later renamed the International Energy Conservation Code (IECC). Today, most states use a version of the MEC or IECC for their residential building code, which requires a minimum level of energy efficiency in new residential construction. Most commercial building codes are based on ASHRAE 90.1, jointly developed by the American Society of Heating, Refrigerating and Air Conditioning (ASHRAE) and the Illuminating Engineering Society (IES). The IECC commercial building provisions also include prescriptive and performance requirements based primarily on ASHRAE requirements.

The most recent versions of the IECC and ASHRAE for which DOE has completed its determination process are the 2009 IECC and the ASHRAE 90.1-2007 standard. While many states have officially adopted the 2009 IECC and/or ASHRAE 90.1-2007, in several states the updated codes will not become effective until late 2011 or beyond. Other states are still in the process of adopting or updating to the more stringent versions.

Requirements in the 2009 IECC are estimated to generate energy savings in residential buildings of 15% above the 2006 IECC (ICF 2009). For commercial buildings, some groups estimate a 4% improvement over the 2006 IECC commercial provisions (SWEEP 2009). The commercial provisions in the IECC, however, consistently differ from those in ASHRAE 90.1, so that the ASHRAE 90.1 standard is generally considered to be more stringent.[40] For example, the latest version of ASHRAE 90.1, which is more commonly used as the standard for commercial buildings than the IECC, is estimated to achieve incremental savings of 8% above ASHRAE 90.1-2004 (PNNL 2009).

The Department of Energy's Building Code Determinations

With the publication of each new edition of the IECC and ASHRAE standards, DOE issues determinations on the codes to ascertain their relative impact when compared to older versions and, if justified, establish the latest iteration as the base code with which all states must comply. While no enforcement mechanism is in place to address non-compliance, states are required to send letters either certifying their compliance, requesting extension, or explaining their decision not to comply within two years of the final determination.

On December July 19, 2011, the DOE issued its final determination on the 2009 IECC, reporting that the 2009 IECC achieves greater energy efficiency than its predecessor editions. DOE estimates that the 2009 IECC achieves 14% greater site energy savings than the 2006 IECC. States must file certification statements with DOE by July 19, 2013.

[40] Some prescriptive measures in the IECC are more rigorous than their ASHRAE equivalent, however. See PNNL (2009) for a detailed comparison of the latest versions.

On July 20, 2011, the DOE issued its final determination on ASHRAE Standard 90.1-2007, reporting that ASHRAE 90.1-2007 achieves greater energy efficiency than its predecessor editions, generating 4.6% more energy savings at site than ASHRAE 90.1-2004. States must file certification statements with DOE by July 20, 2013.

The most recently published versions of the IECC and ASHRAE standards — the 2012 IECC and ASHRAE 90.1-2010 — were published in July 2011. DOE began assessing the relative stringency of the 2012 IECC in November 2010 but has yet to make a preliminary determination. On July 20, 2011, DOE issued a preliminary determination that ASHRAE 90.1-2010 would achieve greater energy efficiency than the 2007 edition.

Building Codes and the American Recovery and Reinvestment Act

The impact of ARRA on building code adoption has shown that federal policy can catalyze tremendous progress among the states. The appropriation of stimulus funding through DOE's State Energy Program (SEP) spurred several dozen states to begin legislative or administrative processes leading to the statewide adoption of the 2009 IECC and ANSI/ASHRAE/IESNA Standard 90.1-2007 (hereafter referred to as the "ARRA codes"[41]). For many states with relatively older codes, the incremental increase in code stringency will be significant and the long-term benefits will far exceed the costs.

States are making progress in their adoption of the latest iterations of these codes. In our *2010 Scorecard*, seventeen (17) states had either adopted or were on a clear path towards the adoption of the ARRA codes for both residential and commercial buildings; and another three (3) had demonstrated progress towards adoption of these codes for either residential or commercial buildings. In this year's *Scorecard*, the number of states that have either adopted or are on a clear path towards the adoption of the ARRA codes for both residential and commercial buildings has increased to twenty-nine (29), while another six (6) have adopted the ARRA codes for either residential or commercial buildings.[42]

ARRA and Building Code Compliance

ARRA also calls for states to achieve 90% compliance with the ARRA minimum standard building energy code (2009 IECC for residential; ASHRAE 90.1-2007 for commercial) by 2017. While some states have made laudable progress in funding and training code officials to ensure enforcement, many will require greater commitment to meet this goal.

To help achieve this goal, the Pacific Northwest National Laboratory (PNNL), which leads the DOE's Building Energy Codes Program (BECP), released a Request for Proposals in August 2010 for states and territories for activities that will facilitate the adoption of and compliance with the most recent building energy codes. A total of $7 million, taken from funding leftover from DOE's State Energy Program (SEP), was awarded to 24 states to engage in a variety of projects, mostly related to code compliance.[43] In addition, a separate source of funding was provided to nine of those states for them to conduct pilot studies on the methodology of measuring compliance, which will include measures of actual compliance rates in each of these states.[44] Other targeted goals of these pilots are: to assist in

[41] In the building energy code community the latest official versions of these codes are referred to as the ARRA codes because of the technical requirement in ARRA to adopt these codes as a prerequisite to dispersal of stimulus funds. Maryland is included in the 29 states, but is the only state that is on track to adopt the 2012 version of the IECC codes.
[42] Two of these six states – Indiana and Virginia – are states that were awarded full credit for residential and commercial buildings in 2010 based on progress they were making towards the adoption of the latest code iterations. These states were docked points relative to their 2010 scores (taking into account the change in our scoring methodology) as the progress that they had shown has stalled or weakening amendments to the codes have been passed.
[43] See http://www.energycodes.gov/arra/documents/StateProjectSummaries.pdf for more details on the specific projects.
[44] For more information on the compliance pilot states, please peruse the following: http://www1.eere.energy.gov/wip/solutioncenter/pdfs/Policies%20and%20Procedures%20for%20Enhancing%20Code%20Compliance.pdf

determining patterns of compliance; to create comprehensive protocols to follow for measuring compliance; and to produce best practices for state building departments to follow when designing training programs.

Utility Involvement in Building Codes

In several states that have passed energy efficiency resource standards (EERS)[45], programs have been established that allow utilities to claim savings for code enhancement activities, both for adoption and compliance. Utilities are in a unique position to assist with state compliance goals, as they offer energy efficiency programs that target building energy efficiency and also collect important data on building energy consumption through utility energy bills. Many utilities across the country offer energy efficiency programs that target improving energy efficiency in new construction specifically, so combining code compliance efforts with efforts to improve energy efficiency beyond code requirements is something that, ideally, would happen concomitantly. For example, utilities can leverage existing relationships with builders and experience measuring savings in new homes.

There are a number of ways that utilities can become involved in augmenting compliance with state and local building codes. Utilities can fund and/or administer training and certification programs, assist local jurisdictions with the implementation of tools that streamline enforcement, provide funding for the purchase of diagnostic equipment, and assist with compliance evaluation. Prudent regulatory mechanisms must be in place to compensate utilities for their efforts, however, in order to encourage them to participate, such as program cost recovery. Allowing utilities to take credit for savings generated through their participation is not enough, as any costs incurred directly reduce utility earnings.

Methodology

For this category, states earned scores on two measures of building energy codes: level of stringency of residential and commercial codes (up to 5 points) and level of efforts to enforce compliance of codes (up to 2 points), for a combined score of up to 7 points.

Our review of state building energy codes is based predominantly on publicly available information such as that provided by the Online Code Environment and Advocacy Network (OCEAN), which maintains maps and state overviews of building energy codes, as well as the DOE's Building Energy Codes Program. The Database for State Incentives for Renewables and Efficiency (DSIRE) also collects and disseminates the status of state energy codes. We assigned each state a score of 0 to 5 for residential and commercial building energy codes, with 5 being assigned to those states exceeding the most stringent codes (see Table 16). We then averaged the two for an overall stringency score (see Table 17). For detailed information on building code stringency in each state, visit ACEEE's State Energy Efficiency Policy Database: http://www.aceee.org/sector/state-policy or see Appendix E.

Because numerous states are still in the process of updating their codes to meet the requirements mandated by ARRA, we awarded full credit to those states that have exhibited progress and show a clear path leading toward the adoption and implementation of the latest versions of the IECC and ASHRAE *within the next year*. In other words, we have not limited qualification to codes that have already become effective, as was the case in our *2008 Scorecard*. However, many states that have begun the process of updating their codes to meet the ARRA requirement have not yet officially adopted the latest IECC and ASHRAE codes nor have they demonstrated a clear path toward adoption with a definitive effective date for implementation. Nonetheless, it is important to note that the processes in these states have begun and are moving along. In Table 17, we denote those states with a clear path toward adoption and implementation with an asterisk and award them full credit. Those states that have begun the adoption process but implementation has either stalled or the

[45] See Chapter 1 on Utility and Public Benefits Programs and Policies.

effective date is uncertain are denoted with a "+" and are awarded credit only for the code versions that are currently effective. Once their efforts have culminated in a clear path toward adoption and implementation of the new codes, the changes will be reflected in future editions of our *Scorecard* and those states will be awarded full credit.

The scoring methodology changes this year to award full credit to states that have introduced state-specific amendments to their building energy codes that render them more stringent than the 2009 IECC and ASHRAE 90.1-2007 or equivalent standards. Given that a handful of states have taken the initiative to improve upon the latest versions of the IECC and ASHRAE 90.1 codes, we believe it is appropriate to reserve them the maximum score. We have also changed the scoring methodology slightly to award credit for states without statewide mandatory building energy codes for various levels of adoptions by major jurisdictions. Many "home rule" states, such as Colorado, Missouri, and Oklahoma, do not have mandatory statewide codes and, instead, adopt and enforce building energy codes at the local level. In these states, some of the local jurisdictions are major urban areas that have adopted the ARRA-level codes and should be given credit for their efforts.

In addition, we also scored states' level of efforts to have builders comply with state building codes. Scoring states on compliance is difficult due to the lack of data—very few states actually collect comprehensive data on residential and commercial compliance with state energy codes. This occurs because states do not typically have enough funding to adequately evaluate the level of compliance within a state. In order to collect information on code compliance and enforcement activities, we distributed a survey to field experts and individuals in each state requesting information regarding their efforts to measure and enforce code compliance, including: (1) published studies that have estimated statewide compliance; (2) enforcement methods; and (3) methods for code official and builder training. States were ranked on a scale of 0 to 2, in 0.5 increments, based on these metrics. States were given 2 points for making substantial efforts in recent years to achieve compliance such as training code officials and funding surveys; 1.5 point for making multiple, but not extensive, efforts; 1 point for some compliance efforts, such as training; 0.5 points for limited efforts; and 0 points for no or unverifiable efforts. See Table 17 for state scores on building energy codes. For more information on state compliance efforts, visit ACEEE's State Energy Efficiency Policy Database: http://www.aceee.org/sector/state-policy or see Appendix F.

Table 16. Scoring Methodology for State Residential and Commercial Building Energy Codes: Stringency

Score	Residential Building Code	Commercial Building Code
5	Exceeds 2009 IECC or equivalent	Exceeds 2009 IECC or ASHRAE 90.1-2007 or equivalent
4	Meets 2009 IECC or equivalent	Meets 2009 IECC or ASHRAE 90.1-2007 or equivalent
3	Meets or Exceeds 2006 IECC or equivalent	Meets or exceeds 2006 IECC or ASHRAE 90.1-2004 or equivalent
2	1998-2003 MEC/IECC (meets EPCA[46]) or significant adoptions in major jurisdictions	1998–2003 IECC or ASHRAE 90.1-1999/2001 or equivalent or significant adoptions in major jurisdictions
1	No mandatory state energy code, but some adoptions in major jurisdictions	No mandatory state energy code, but some adoptions in major jurisdictions
0	No mandatory state energy code or precedes 1998 MEC/IECC (does not meet EPAct of 1992)	No mandatory state energy code or precedes ASHRAE 90.1-1999 or equivalent (does not meet EPAct of 1992)

[46] Under the federal Energy Policy and Conservation Act, states are required to review and adopt the MEC/IECC and the most recent version of ASHRAE Standard 90.1 for which DOE has made a positive determination for energy savings (currently 90.1-2004) or submit to the Secretary of Energy its reason for not doing so.

Note: States that have adopted the 2009 versions of the IECC and ASHRAE 90.1 or are on a clear path toward their adoption within the next twelve (12) months are given full credit.

Table 17. State Residential and Commercial Building Energy Codes: Stringency and Compliance Efforts Scoring

State	Stringency			Compliance Efforts Score	Overall Score
	Residential State Energy Codes	Commercial State Energy Codes	Score (Average)		
California	5	5	5	2	**7**
Massachusetts	5	5	5	2	**7**
Oregon	5	5	5	2	**7**
Washington	5	5	5	2	**7**
Georgia	5	5	5	1.5	**6.5**
Idaho	4	4	4	2	**6**
New York	4	4	4	2	**6**
Florida*	4	4	4	1.5	**5.5**
Utah	3	4	3.5	2	**5.5**
Montana	4	4	4	1.5	**5.5**
District of Columbia	5	4	4.5	1	**5.5**
Connecticut	4	4	4	1.5	**5.5**
New Hampshire	4	4	4	1.5	**5.5**
Maryland	5	5	5	0.5	**5.5**
Virginia	3	4	3.5	1.5	**5**
Iowa	4	4	4	1	**5**
Pennsylvania	4	4	4	1	**5**
Illinois	4	4	4	1	**5**
North Carolina*	4	4	4	1	**5**
Nebraska	4	4	4	1	**5**
Rhode Island	4	4	4	1	**5**
Wisconsin	3	4	3.5	1.5	**5**
Vermont+	4	4	4	1	**5**
Hawaii	4	4	4	1	**5**
Nevada	4	4	4	1	**5**
Kentucky	3	4	3.5	1	**4.5**
Maine	4	4	4	0.5	**4.5**
New Jersey	4	4	4	0.5	**4.5**
Delaware	4	4	4	0.5	**4.5**
Michigan	4	4	4	0.5	**4.5**
Texas	4	4	4	0.5	**4.5**
New Mexico	4	4	4	0.5	**4.5**
Alabama+	4	4	4	0.5	**4.5**
Indiana+	3	4	3.5	0.5	**4**
Ohio	3	4	3.5	0.5	**4**
Minnesota	3	3	3	1	**4**
Louisiana	3	3	3	1	**4**
Tennessee	3	3	3	1	**4**
Colorado	2	2	2	1.5	**3.5**
South Carolina	3	3	3	0	**3**

State	Stringency			Compliance Efforts Score	Overall Score
	Residential State Energy Codes	Commercial State Energy Codes	Score (Average)		
West Virginia	2	2	2	1	**3**
Arizona	2	2	2	1	**3**
Arkansas	2	2	2	0.5	**2.5**
Alaska	4	0	2	0	**2**
Missouri	2	2	2	0	**2**
Kansas	1	1	1	0.5	**1.5**
Oklahoma	1	1	1	0.5	**1.5**
South Dakota	0	0	0	0	**0**
Mississippi	0	0	0	0	**0**
North Dakota	0	0	0	0	**0**
Wyoming	0	0	0	0	**0**

Sources: Stringency scores derived from BCAP (2010) and DOE (2010b), as of September 2010. Compliance and enforcement scores based on information gathered through survey of state building code contacts. See ACEEE's State Energy Efficiency Policy Database for more information on state compliance efforts: http://www.aceee.org/sector/state-policy.

* These states have signed or passed legislation mandating compliance with the 2009 IECC and/or ASHRAE 90.1-2007, effective at a later date, or their rulemaking processes are far enough along that mandatory compliance with the most recent energy codes is imminent. These states are given full credit.

+ These states have signed or passed legislation mandating compliance with the 2009 versions of the IECC or ASHRAE 90.1, but have not demonstrated a clear path forward toward their adoption, so that the effective date remains uncertain. These states are not awarded credit for the 2009 versions of the codes.

California, Oregon, and Washington earned the maximum score of 7 points because their state-developed codes are considered to be more stringent than the highest IECC standards and they have also been estimated to have some of the highest rates of compliance. Massachusetts earns a full 7 points for its solid compliance efforts and its "stretch code", which allows communities to adopt an enhanced version of the 2009 IECC. States that have not adopted a mandatory state energy code, or have poor or unverifiable rates of compliance, earn a score of 0. Currently there are eleven states that do not have statewide, mandatory energy codes for either residential or commercial buildings. The eleven are Alabama, Alaska, Arizona, Colorado, Kansas, Mississippi, Missouri, North and South Dakota, Oklahoma, and Wyoming. Seven states have no verifiable rates of compliance, down from eleven in our *2010 Scorecard*.

Figure 8. Leading States: Building Energy Codes

Nebraska: On August 24, 2011, the Nebraska Energy Code, codified in Nebraska Administrative Code Title 107, will be updated to meet the 2009 IECC and ASHRAE 90.1-2007, respectively. Nebraska's building energy codes had not been updated since 2004, when the 2003 IECC became effective. The update to the most recent versions of the codes was introduced as LB 329 in January 2011 and approved by the Urban Affairs Committee February 25, 2011. The full Nebraska chamber gave final approval on April 8, and the bill was signed by Governor Dave Heineman on April 14. To provide education on the new codes, the Nebraska Energy Office announced a schedule of free training opportunities for the building community. Nebraska is also one of the 24 states that was awarded funding for efforts into augment state energy code compliance. A baseline compliance study is currently underway.

Georgia: On January 1, 2011, the 2011 Georgia State Minimum Standard Energy Code became effective statewide as approved by the Georgia Department of Community Affairs on November 3, 2010. The state code is based on the 2009 IECC with 2011 Georgia Amendments and is mandatory statewide. The commercial codes also reference ASHRAE 90.1-2007. The state also adopted the 2011 Georgia State Minimum Residential Green Building Standard, based on the 2008 National Green Building Standard (NGBS) with 2011 Georgia Amendments, as an optional code. It is available for local government adoption and enforcement. Georgia is also one of the 24 states that was awarded funding for efforts to augment state energy code compliance and was one of the nine states to receive funding to conduct a compliance pilot study. With the help of this funding, Georgia has been able to bolster its compliance efforts considerably.

CHAPTER 4: COMBINED HEAT AND POWER

Author: Anna Chittum

Combined heat and power systems generate electricity and thermal energy in a single, integrated system. CHP is more energy efficient than separate generation of electricity and thermal energy because heat that is normally wasted in conventional power generation is recovered as useful energy. That recovered energy is used to satisfy an existing thermal demand, such as the heating and cooling of a building or industrial process heating and cooling. CHP systems can save customers money and reduce overall net emissions.

A state could earn up to 5 points based upon its adoption of regulations and policies that encourage the deployment of CHP systems. There are multiple ways in which states can actively encourage or discourage the deployment of CHP. Financial, technical, and regulatory factors all impact the extent to which CHP is deployed. The six factors considered when scoring CHP for the 2011 Scorecard are:

- Standard interconnection rules currently in place
- Status of CHP-friendly standby rates
- Presence of CHP financial incentive programs
- Presence of output-based emissions regulations (OBR)
- Inclusion of CHP/waste heat recovery in a state RPS or EERS or other standard
- Net metering regulations currently in place

Some states are in the process of developing or improving a number of these policies for CHP. Generally, credit was not given for a policy unless it was in place—enacted by a legislative body or promulgated as an order from an agency or regulatory body. Some states that formerly had policies in place have since removed or in other ways nullified these policies; in these situations, we did not give credit for the policy in question. Policies in place as of June 2011 were considered for this review.[47]

The most heavily weighted policy is the presence of an **interconnection standard** that explicitly establishes parameters and procedures for the interconnection of CHP systems. We relied upon secondary sources—such as the *Database for State Incentives for Renewable Energy* (DSIRE 2011) and the Environmental Protection Agency's *CHP Partnership* database (EPA 2011)—as well as primary sources such as public utility commission dockets and interviews with commission staff and utility representatives. Having multiple tiers of interconnection is important to CHP deployment because smaller systems are offered a faster—and often cheaper—path toward interconnection compared to larger systems. Scaling these transaction costs to project size makes economic sense, because customers with larger projects and potential economic gains often have more incentive to spend time and money to interconnect their more complex systems than do customers with smaller projects facing smaller economic returns. Additionally, interconnection standards that have higher size limits are preferred by CHP developers, as are standards that are based upon widely accepted technical industry standards, such as the IEEE 1547 standard.[48] Other favorable interconnection practices include the applicability to all utilities, not just investor-owned utilities; a maximum capacity of 10-20 MW or more; the prohibition of redundant external disconnect switches; and the prohibition of additional insurance requirements. Finally, having clearly delineated procedural steps toward

[47] The rankings in this chapter do not reflect the number or size of in-place CHP systems in each state. Nor do they reflect external market factors contributing to CHP deployment such as fuel cost and grid-supplied energy costs. Such elements heavily influence CHP markets, but they are not necessarily representative of state-level CHP policy. Substantial CHP deployment is not always correlated with ideal CHP policies, and similarly a lack of such ideal CHP policies is not always correlated with low levels of CHP deployment. ACEEE's recent report, *Challenges Facing Combined Heat and Power Today: A State-by-State Assessment,* addresses and explores this dichotomy (http://aceee.org/research-report/ie111). In future *Scorecard* reports, ACEEE expects to integrate these additional market forces and CHP deployment figures into its rankings of state CHP policies.

[48] This standard establishes criteria and requirements for interconnection of distributed energy resources with electric power systems (EPS). It provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. For more information, visit http://www.ieee.org/portal/site.

interconnection, easily accessible information about the interconnection process and a method by which customers may officially contest a denied interconnection request are all viewed favorably.

Weighted slightly less than interconnection standards are the **standby rates** used by utilities in each state to charge for standby service provided to CHP systems. We relied upon secondary information that came from the Environmental Protection Agency's *CHP Partnership*, as well as primary information from utilities and public utility commissions to score states for this category. Standby rates are generally composed of two elements: energy charges, which reflect the actual standby energy used by a CHP system; and demand charges, which are charges based upon either a single demand peak during a defined period or a specific amount of contracted demand based upon the system's size. Demand charges may often increase significantly based upon a single demand peak during a single 15-minute period. Demand charges can further discourage CHP when a "ratchet" is employed, which maintains the heightened demand charge high for as much as a year or longer.

The next most weighted CHP policy is the presence of **incentives for CHP**. Tax incentives tend to be more permanent than grant programs, which are generally not embedded in state legislation. Tax incentives for CHP take many forms, but are often credits taken against business or real estate taxes. Rebates, grants, bonds, and favorable loan structures are all ways in which CHP can be encouraged at the state level, and the leading states have mixtures of multiple types of incentives. Financial incentives offered through state entities that apply to all CHP systems are preferred, but some credit was also given to incentives for exclusively biomass CHP projects, government *lead by example* CHP programs, and strong utility incentives that encourage CHP development. Additional information on incentives for CHP is available from EPA through its CHP Partnership (EPA 2011) and from the Database for State Incentives for Renewable Energy (DSIRE 2011).

Equal in weight to financial incentives is the presence of **output-based emissions regulations (OBR)**. These are air quality regulations that take the useful energy output of CHP systems into consideration when quantifying a system's criteria pollutant emissions. Many states employ emissions regulations for generators by calculating levels of pollutants based upon the fuel input into a system. For CHP systems, electricity *and* useful thermal outputs are generated from a single fuel input. Therefore, calculating emissions based solely on input ignores the additional power created by the system, using little or no additional fuel. Output-based emissions acknowledge that the additional useful energy output was created in a manner generally cleaner than the separate generation of electricity and thermal energy. Additional information for policies in this category is also available from EPA via its Partnership Web site.[49] New and forthcoming rules from the EPA regulating emissions from multiple sources will dramatically alter the way emissions from some CHP systems are calculated and regulated. State regulatory approaches and programs currently in place that affect the way in which CHP system emissions are regulated may be rendered moot by future EPA activity. Such changes will be reflected in the 2012 Scorecard.

The next most weighted policy used to calculate states' overall CHP scores is the eligibility of **CHP for credit in a renewable portfolio standard (RPS), energy efficiency resource standard (EERS)** or other energy standard. RPS and EERS policies define a particular amount of a state's electric resources that must be derived from renewable energy or energy efficiency resources, respectively, as is discussed in Chapter 1. Most states with RPS or EERS policies set goals for future years. These goals are generally a percentage of total electricity sold that must be derived from renewable or efficiency resources, with the percentage of these resources increasing as a percentage of total electricity sold in future years. Not only are utilities required to meet the state goals, but these standards are often paired with financial incentives or support programs to implement and encourage eligible technologies. Thus, when CHP is explicitly listed as eligible for RPS or EERS credit, it creates a large incentive to deploy CHP systems.

The final state policy considered in this chapter is the presence of **net metering** regulations that apply to CHP. Net metering is most commonly applied to renewable energy systems, but can also be

[49] See http://www.epa.gov/chp/state-policy/output.html.

applicable to small combined heat and power (CHP) systems, often those under 1 or 2 MW. Sound net metering regulations allow owners of small distributed generation systems to get credit for excess electricity that they produce on-site. Under net metering rules, distributed generation system owners are compensated for some or all excess generation either at the utility's avoided cost, or, less often, at higher retail rates. The levying of fees on net-metered systems, along with rules that set overly strict limits on individual system and aggregate capacity size, serve as barriers to deployment of CHP and other distributed generation systems. Limits on individual and aggregate system capacities can prevent system owners from installing the most efficient or cost-effective systems, and sometimes even prevent them from meeting on-site load requirements. Any size limits should be based only on objective engineering standards and facility load requirements. Other best practices for net metering include eligibility for all distributed generation technologies, including CHP; eligibility for all customer classes; system size limits that exceed 2 MW; indefinite net excess generation carryover at the utility's retail rate; and prohibition of special fees for net metering.

States are scored for CHP on a scale of 0 to 5 on their efforts to encourage CHP through the above regulatory and financial mechanisms, as listed in Table 18. In addition to absolute rankings of each policy, states are also compared to each other. Consequently, what constitutes an Overall Score of 5 may change slightly each year as the leading states adopt new and novel policies not previously in existence. Similarly, as lagging states raise the floor by adopting new policies, what constitutes an Overall Score of 0 may also change.

Table 18. Scoring Methodology for CHP

Total Score	Overall Score
15 – 24	5
11.25 – 14.75	4
8 – 11	3
6 – 7.75	2
3.25 – 5.75	1
0 – 3	0

Table 19. State Scoring for CHP

State	Inter-connection	Standby Rates	Incentives	OBR	RPS or EERS	Net Metering	Total Score	Overall Score
Maximum Score	***6***	***5***	***4***	***4***	***3***	***2***	***24***	***5***
Maine	6	5	0	4	3	1	19	**5**
Connecticut	6	3	2	3	3	1	18	**5**
Massachusetts	5	1.25	1	4	3	2	16.25	**5**
Ohio	6	1.25	2	3	3	1	16.25	**5**
North Carolina	4	1.25	4	0	3	2	14.25	**4**
Oregon	5	3	3	1	1	1	14	**4**
Illinois	6	2.5	3	0	1	1	13.5	**4**
Pennsylvania	4	2.5	2	0	3	2	13.5	**4**
Texas	5	2.5	0	3	3	0	13.5	**4**
New York	4	1.25	4	2	1	1	13.25	**4**
District of Columbia	6	5	0	0	0	2	13	**4**
New Jersey	3	3	4	1	1	1	13	**4**
Colorado	5	2.5	1	0	3	1	12.5	**4**
Maryland	6	2.5	1	0	1	2	12.5	**4**

State	Inter-connection	Standby Rates	Incentives	OBR	RPS or EERS	Net Metering	Total Score	Overall Score
California	5	3	2	2	0	0	12	**4**
New Mexico	6	0	3	0	1	2	12	**4**
Wisconsin	5	2.5	1	1	1	1	11.5	**4**
Washington	4	1.25	1	2	2	1	11.25	**4**
Utah	6	0	2	0	1	2	11	**3**
Hawaii	2	3.75	1	0	3	1	10.75	**3**
New Hampshire	1	2.5	4	1	1	1	10.5	**3**
Indiana	4	2.5	0	1	1	1	9.5	**3**
Minnesota	5	2.5	0	0	1	1	9.5	**3**
Arizona	0	1.25	3	0	3	2	9.25	**3**
South Dakota	6	1.25	1	0	1	0	9.25	**3**
Vermont	2	1.25	4	0	1	1	9.25	**3**
Delaware	2	2.5	1	3	0	0	8.5	**3**
Rhode Island	1	2.5	2	0	2	1	8.5	**3**
Tennessee	4	1.25	2	0	0	1	8.25	**3**
Michigan	3	0	2	0	2	1	8	**3**
Nevada	1	3	1	0	2	1	8	**3**
Virginia	5	0	1	1	0	1	8	**3**
Florida	3	1.25	1	0	0	2	7.25	**2**
Alaska	1	2.5	3	0	0	0	6.5	**2**
Idaho	0	2.5	3	0	0	1	6.5	**2**
West Virginia	2	2.5	0	0	1	1	6.5	**2**
Iowa	5	0	1	0	0	0	6	**2**
Missouri	1	2.5	0	1	0	1	5.5	**1**
Montana	0	2.5	2	0	1	0	5.5	**1**
Kentucky	1	1.25	2	0	0	1	5.25	**1**
North Dakota	0	1.25	1	0	1	1	4.25	**1**
Kansas	1	0	2	0	0	1	4	**1**
South Carolina	1	0	2	0	0	1	4	**1**
Arkansas	1	1.25	0	0	0	1	3.25	**1**
Mississippi	0	1.25	2	0	0	0	3.25	**1**
Nebraska	1	1.25	0	0	0	1	3.25	**1**
Alabama	0	0	3	0	0	0	3	**0**
Louisiana	1	0	0	0	1	1	3	**0**
Wyoming	0	0	1	0	0	1	2	**0**
Georgia	0	0	1	0	0	0	1	**0**
Oklahoma	0	0	1	0	0	0	1	**0**

While many states saw at least some incremental improvement in CHP policies between 2011 and 2010, several specific policies now in place can be viewed as “game changers,” and as leading examples of CHP-friendly policies. Figure 9 describes the three most notable policies currently in place:

Figure 9. Leading State Policies: Combined Heat & Power

Maine: In 2010, Maine adopted a new interconnection standard applicable to all distributed generation, including all CHP. There are multiple tiers for interconnection, and fixed engineering fees and limited study costs ensure that the cost of interconnection is controlled. This interconnection standard is considered by many to be the best standard currently in place today.

North Carolina: North Carolina's recently adopted tax credit for renewable energy systems offers a 35% credit of the cost of eligible energy property, specifically including CHP systems. The incentive maximum is $2.5 million and there is no cap on the maximum system size. There is also no restriction on system fuel. This incentive is by far the largest state-level tax incentive available for CHP systems.

New Jersey: Though New Jersey does not have an ideal interconnection standard, the practices of its utilities are generally favorable toward CHP systems vis-à-vis interconnection. More significantly, New Jersey recently adopted a rule defining two sites as contiguous if one buys thermal energy from the other. In this way, the seller of thermal energy may also sell electricity to the buyer, utilizing "existing locally franchised public utility electric distribution infrastructure." This electricity may cross public thoroughfares or utility rights-of-way.

CHAPTER 5: STATE GOVERNMENT INITIATIVES

Author: Michael Sciortino

Background

State legislatures and governors can advance policies and programs that impact utility-sector energy efficiency, transportation efficiency, combined heat and power, and building codes. This chapter, however, is dedicated to the energy efficiency initiatives designed, funded, and implemented by a broad array of state-level administrators such as state energy offices, universities, and economic development and general services agencies (Sciortino and Eldridge 2010). In this chapter we focus on three initiatives commonly undertaken by state governments: financial incentive programs for consumers, businesses, and industry; policies and programs to improve the energy efficiency of its facilities and fleets; and research, development, and demonstration (RD&D) activities for energy efficiency technologies and practices.

In light of the wave of energy efficiency funding to the states from the American Recovery and Reinvestment Act (ARRA) and the infrastructure it laid for continuing energy efficiency programs, it is critical to recognize state government initiatives, which play unique roles fostering an energy-efficient economy. State-led programs complement the existing landscape of utility programs, leveraging the state's public and private resources to generate energy and cost savings to the benefit of its customers and taxpayers (Sciortino 2010). Financial incentives offered by state agencies can be a deciding factor for consumers or businesses to invest in energy-efficient technologies or services. "Lead by example" (LBE) policies and programs improve the energy performance of state-owned facilities and fleets, but equally important, these initiatives showcase cost-effective energy efficiency measures to the wider public. State governments can also promote innovative energy efficiency solutions through RD&D initiatives administered by local universities or research centers.

Methodology

States can earn a maximum of 7 points in this category in three categories: (1) financial and information incentives; (2) lead by example (LBE) policies and programs in government buildings and fleets; and (3) research, development, & demonstration (RD&D).

We primarily rely on the *Database of State Incentives for Renewable Energy* (DSIRE 2011) to gather information on current state tax and other financial incentive programs for buildings and equipment efficiency. We also conduct independent, primary research to supplement the financial and information incentive information contained in DSIRE, reviewing state government websites and other online resources provided by the National Governor's Association, the National Association for State Energy Officials, and the Institute for Market Transformation (NGA 2010) (NASEO 2011) (IMT 2011). Points are not given for utility ratepayer-funded financial incentive programs, which are covered in Chapter 1. Programs solely funded by ARRA are not counted (see below). Acceptable sources of funding include state appropriations or bonds, oil overcharge revenues, auction proceeds from the Regional Greenhouse Gas Initiative, and other non-utility ratepayer sources. Tax incentives are also included in the scoring. If a state contributes non-ratepayer funds to a public benefits fund, however, they may earn a point. While there is some overlap of state and ratepayer funding, for example where state RD&D is funded through a systems benefits charge, this chapter is designed to capture energy efficiency initiatives not already covered in Chapter 1.

States earn up to three points for each major incentive program that encourages the purchase of energy-efficient products, which are judged upon their relative strength, customer reach, and impact.[50] Given their broader impact in most cases, for example, tax credits earn a full point, while

[50] "Energy-efficient products" include any product or process that reduces energy consumption. While they may reduce energy consumption, renewable energy technologies such as solar hot water heating are not included because they are typically part

financial incentives offered to a specific customer segment may earn a half-point. States are also given credit for energy use disclosure laws, which require commercial and residential building owners to disclose information about the energy efficiency of their building to prospective buyers, lessees, or lenders. Scoring for disclosure requirements is based on the strength of the policy, and whether both commercial and residential buildings are covered. Experts internal and external to ACEEE vet the financial incentive scores to ensure they represent an accurate representation of financial and information incentives offered in the states.

Our review of state lead by example initiatives is based on information from DSIRE, the Department of Energy Alternative Fuel and Advanced Vehicles Data Center,[51] an information request sent to all the states, and independent research (DOE 2011a). States earn a maximum of 2 points in the LBE category: 0.5 point for energy savings targets in new and existing state buildings; 0.5 point for a benchmarking requirement for public facilities; 0.5 point for robust energy performance savings contracting activities; and 0.5 point for fleet efficiency mandates. Energy savings targets must commit state government facilities to a specific energy reduction goal over a distinct time period. A benchmarking policy refers to a requirement that all buildings undergo an energy audit or have their energy performance tracked using a recognized tool such as EPA ENERGY STAR Portfolio Manager. Robust public-sector energy benchmarking programs may also qualify for the half-point. Scoring on energy performance savings contracting activity is based on three metrics: encouragement, leadership, and resources.[52] For state fleet initiatives, states only earn a point if the plan or policy makes a specific, mandatory requirement for increasing state fleet efficiency. State alternative-fuel vehicle procurement requirements that give a voluntary option to count efficient vehicles are thus not included.

The RD&D review is based on state participation in the Association of State Energy Research Technology and Transfer Institutions (ASERTTI) and the size of effort relative to population as assessed by ACEEE staff. In general, a point is awarded for each major R&D program funded by the state government, including programs administered by state government agencies, public-private partnerships, and university programs dedicated to energy efficiency. A state can receive up to two points in this category. Because funding often fluctuates and it is difficult to determine how much of it supports RD&D specifically focused on energy efficiency, devising a quantitative metric based on RD&D funding is outside the scope of this report. Instead, points are assigned by ACEEE and vetted by outside experts. The review also includes independent research and considers responses from state officials to an information request sent last year on state-level RD&D activities.

of broader renewable energy incentive packages that would not result in energy efficiency gains. This issue will be reviewed in further detail for the 2012 *Scorecard*.

[51] Information request sent to gain primary information on state facility benchmarking policies and programs, as well as energy savings performance contracting activities.

[52] The ESPC **encouragement** metric requires that the state explicitly promotes the usage of ESPCs to improve the energy efficiency of public buildings. The following methods of encouragement were identified and given recognition: statutory requirements for using ESPCs, statutory recommendation of ESPCs as a method of achieving efficiency improvements, explicit preference for ESPCs through statutes, executive orders that explicitly promote or require ESPCs, and/or financial incentives for agencies seeking to use ESPCs. States earning recognition for an ESPC **leadership** were those that have either set up a distinct program that directly coordinates ESPC efforts (and, on occasion, other energy efficiency projects, as well) or housed the state support for ESPCs within a specific state agency that serves as the lead contact for implementing ESPCs in the state. Lastly, the ESPC **resources** category is defined by states that offer documents that help streamline and standardize the ESPC process. Such documents include: a list of prequalified ESCOs, model contracts and other documents, and/or a manual that lays out the procedures required to utilize an ESPC. A state was awarded 0.5 point if it satisfied at least **two of the three** categories described. States were given the opportunity to review information gathered by ACEEE prior to scoring in order to attain maximum accuracy in our research.

Table 20. Summary of Scoring on State Government Initiatives

State	Financial Incentives	Lead by Example	RD&D	Total
Maximum Score	***3***	***2***	***2***	***7***
Massachusetts	3	2	2	7
New York	3	1.5	2	6.5
Oregon	3	1.5	2	6.5
Alaska	3	1	2	6
Colorado	3	2	1	6
Minnesota	3	2	1	6
California	1.5	2	2	5.5
North Carolina	2	1.5	2	5.5
Tennessee	3	1.5	1	5.5
Iowa	2	1	2	5
Michigan	2	1	2	5
Delaware	2	2	0.5	4.5
New Hampshire	3	1.5	0	4.5
Ohio	2	1.5	1	4.5
Maryland	3	1	0	4
Pennsylvania	3	1	0	4
Texas	1.5	1.5	1	4
Connecticut	1.5	2	0	3.5
Hawaii	1	2	0.5	3.5
Illinois	1.5	1.5	0.5	3.5
Indiana	2	1	0.5	3.5
New Jersey	1	1.5	1	3.5
New Mexico	1.5	1	1	3.5
Wisconsin	0	1.5	2	3.5
Florida	0.5	1.5	1	3
Idaho	2	1	0	3
Kentucky	1.5	1.5	0	3
Missouri	1.5	1.5	0	3
Utah	1	2	0	3
Vermont	1.5	1.5	0	3
Virginia	1	1	1	3
Washington	1	2	0	3
Arizona	1	1.5	0	2.5
District of Columbia	1.5	1	0	2.5
Georgia	1	1	0.5	2.5
Louisiana	1.5	1	0	2.5
Maine	1	1.5	0	2.5
Mississippi	1	1.5	0	2.5
Montana	1.5	1	0	2.5
Nebraska	2	0.5	0	2.5
South Carolina	1	1.5	0	2.5
West Virginia	0	0.5	2	2.5
Alabama	0.5	1.5	0	2
Arkansas	0.5	1.5	0	2

State	Financial Incentives	Lead by Example	RD&D	Total
Rhode Island	0.5	1.5	0	2
South Dakota	0.5	1	0.5	2
Kansas	1	1	0	2
Nevada	1	0.5	0	1.5
Oklahoma	1	0.5	0	1.5
Wyoming	1	0.5	0	1.5
North Dakota	0.5	0	0	0.5

The American Recovery and Reinvestment Act and State Governments

The American Recovery and Reinvestment Act passed in February 2009 included the largest single investment in energy efficiency in U.S. history. The law directed approximately $17 billion to improve the country's energy efficiency and a substantial share went to the states from the Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), as listed in Table 21.[53] Additional programs that may indirectly fund state and local government programs include the Advanced Research Projects Agency-Energy (ARPA-E), which funds numerous energy efficiency research projects at state universities. Particularly in states minimally served by utility programs, these programs can provide an important first step to introduce consumers and decision-makers to the benefits of energy efficiency programs.

Table 21. ARRA Energy Efficiency Funding to State and Local Governments

Program	FY 2008 Budget	Stimulus Funding
Weatherization Assistance Program	$227 million	$5 billion
State Energy Program	$33 million[54]	$3.1 billion
Energy Efficiency and Conservation Block Grant Program	N/A	$3.2 billion
Appliance Rebate Program	N/A	$300 million
Total	**$260 million**	**$11.6 billion**

While ARRA's main intent was to stimulate rapid job growth, its effects on state-level energy efficiency programs will certainly last years, if not decades. From the outset, state governments were encouraged to use ARRA funds to establish energy efficiency financing mechanisms that could leverage private sector capital and maximize the usefulness of the funds. Thirty-five states have established 51 revolving loan funds (RLFs) with approximately $650 million in ARRA funds, which could finance approximately $150-200 million per year of energy projects over the next 20 years (Goldman et al. 2011).[55] ARRA also cemented better connections between state energy offices, the Department of Energy and lending institutions, in particular Community Development Financial Institutions (Freehling 2011). Along with its lasting effects on state-level energy efficiency, ARRA established connections between state and local governments to advance building and transportation energy efficiency at the community level (Sciortino 2011). In order to receive and spend Energy Efficiency and Conservation Block Grants, local governments developed knowledge and staff capacity to implement energy efficiency projects, providing solid foundation for future programs.

[53] An additional $15 billion was allocated to programs and projects in which funding could be used for energy efficiency improvements among numerous other modernization or renovation measures.
[54] Required states to contribute funds worth 20% of the DOE grant toward energy projects supported by the grant.
[55] For analysis of the initial implementation phase of energy-related ARRA funding at the state level, see (Goldman et al. 2011).

ARRA-Funded Programs and Scoring

State programs funded solely through ARRA, or any other federal source, do not earn points in the *Scorecard*. Because of the even distribution of the funding, the existence of these programs does not necessarily reflect the efforts of the state, but rather the federal government. Completing an assessment of a state's handling of stimulus funds would rely on fluctuating spending data and rests outside the scope of this report. ACEEE does recognize, however, that some states are implementing these federal funds in an exemplary fashion by creating innovative and effective energy efficiency programs. Some of these examples are presented in a recent ACEEE report (see Sciortino 2010) and many more examples are available through the Department of Energy and National Association of State Energy Officials.[56]

Financial and Information Incentives

Financial incentives are an important instrument to spur the adoption of technologies and practices in homes and businesses. Financial incentives can take many forms: rebates, loans, grants, or bonds for energy-efficient improvements; direct income tax credits for individuals or businesses; exemptions or reduced sales tax on eligible products; and income tax deductions for individuals and businesses. Financial incentives can lower the upfront cost and shorten the payback period of energy-efficiency upgrades, two critical barriers which often impede consumers and businesses from making cost-effective efficiency investments. Incentives also raise consumer awareness of eligible products, encouraging manufacturers and retailers to market these products more actively. As sales increase, prices come down, eventually allowing the products to function in the market without the incentives. Information incentives such as building energy disclosure laws improve consumers' purchasing power by raising awareness of the energy usage of homes and commercial buildings on the market, which can have a significant impact on the economic value of a home or building from a retail perspective. A requirement to disclose a building's energy-use characteristics also provides building owners incentive to improve the energy efficiency of facilities.

Table 22. State Scoring on Major Financial and Information and Incentive Programs

State	Major State Financial Incentives Programs	Score
Alaska	Four loan programs; one rebate program; home energy disclosure policy	3
Maryland	Income Tax Credit For Green Buildings (personal & corporate); four loan programs; grant and rebate programs	3
Massachusetts	Alternative Energy and Energy Conservation Patent Exemption (personal & corporate); grant and rebate programs; home energy disclosure policy	3
Oregon	Residential and business energy tax credit; one grant and two loan programs	3
Pennsylvania	State-led Alternative Energy Fund; six grant and five loan programs	3
Minnesota	Six loan programs	3
New Hampshire	Three loan programs; grants through Greenhouse Gas Reduction Fund	3
Tennessee	Two loan programs; Energy Efficient Schools Initiative (loans and grants); tax credits for energy efficiency businesses	3
New York	Green Building Tax Credit Program (personal & corporate); home energy disclosure policy, rebate programs, and Green Jobs/Green NY loans	3
Delaware	One grant program, loan program, and bond-financed public buildings program	2
North Carolina	One loan and one grant program; three rebate programs	2
Ohio	Advanced Energy Program Grants; one loan program; property tax incentives	2
Idaho	Insulation income tax deduction; one grant program; one low interest energy loan program	2
Michigan	Energy Efficient Home Improvements Tax Credit; grant and loan programs	2
Indiana	Corporate and Personal Energy Savings Tax Credits; two grant programs	2

[56] See the website for the Weatherization & Intergovernmental Programs (http://www1.eere.energy.gov/wip/recovery_act.html) within the Department of Energy's Office of Energy Efficiency and Renewable Energy. Also, see (NASEO 2011).

State	Major State Financial Incentives Programs	Score
Iowa	Iowa Building Energy $mart Program; two grant programs	2
Nebraska	Dollar and Energy Savings Loans	2
Louisiana	Home Energy Rebate Option; Home Energy Loan Program	1.5
Missouri	Tax deduction for home energy efficiency improvements; one loan program	1.5
Montana	Energy conservation installation tax credit; tax deduction for energy-conserving investment; one loan program	1.5
New Mexico	Sustainable Building Tax Credit (personal & corporate); bond program	1.5
Texas	Texas LoanSTAR program; energy efficiency disclosure policy	1.5
Vermont	Two loan programs, one grant program	1.5
California	One grant program; sales tax exemption for alternative energy manufacturing equipment; energy disclosure policy (commercial)	1.5
Connecticut	Two loan programs; sales tax exemption for energy-efficient products	1.5
District of Columbia	Energy efficiency disclosure policy (commercial); one rebate program	1.5
Illinois	One grant, one loan, one bond program	1.5
Kentucky	Energy efficiency tax credits (personal, corporate, and sales)	1.5
Nevada	Property tax abatement for green buildings	1
Colorado	Loan program for energy efficiency in schools	1
Arizona	Property tax exemption for energy-efficient building components	1
Georgia	Corporate and Personal Clean Energy Tax Credits	1
Hawaii	Home energy disclosure policy in place	1
Kansas	Kansas Energy Efficiency Program for Schools (KEEPS); home energy disclosure policy	1
Maine	Building disclosure policies (residential and commercial)	1
Mississippi	One loan program, one public-sector lease program for efficient equipment	1
New Jersey	One loan/grant program, energy efficiency incentive for low-income housing tax credit program (LIHTC Green Point)	1
Oklahoma	Three loan programs	1
South Carolina	Tax credit for purchase of new energy-efficient manufactured homes; one loan program	1
Utah	Two loan funds for state-owned buildings and schools	1
Virginia	Energy Leasing Program for state-owned facilities	1
Washington	Manufacturing Efficiency Grant Program; energy efficiency disclosure policy	1
Wyoming	One loan and one grant program	1
Alabama	Loan program for state-owned facilities	0.5
Arkansas	Loan program for small businesses	0.5
North Dakota	One grant program for public facilities	0.5
Rhode Island	RI HEAT loan program	0.5
South Dakota	Home energy disclosure policy (new residential)	0.5
Florida	One rebate program (expired)	0.5
West Virginia	None	0
Wisconsin	None	0

Source: Database of State Incentives for Renewables and Efficiency (DSIRE 2011)
Note: Utility (ratepayer) funded financial incentives, including those run through public benefits funds and third-party administrators, are included in scoring on utility spending in Chapter 1.

Figure 10. Leading States: State Financial and Information Incentives

Alaska: While the state lacks robust ratepayer-funded energy efficiency programs, Alaska uses a substantial amount of state appropriations to fund energy efficiency incentive programs. The Home Energy Rebate Program utilizes $160 million in state funding appropriated in 2008, a major investment relative to the small population of Alaska. The program allows rebates of up to $10,000 based on improved efficiency and eligible receipts. Energy ratings are required before and after the home improvements to provide expert advice and to track savings. On top of the rebate program, the state legislature appropriated $200 million for its Weatherization Assistance Program, bringing total funding in 2008 to $360 million. In 2011, the state appropriated $101.5 million for both the rebate and weatherization programs.

Tennessee: Tennessee has partnered with Pathway Lending to provide low-interest energy efficiency loans to commercial customers. The state also offers energy efficiency loans to local governments and schools. Tax credits are also available for the manufacture of energy-efficient technologies.

The Regional Greenhouse Gas Initiative and Energy Efficiency

The Northeast Regional Greenhouse Gas Initiative (RGGI), which caps greenhouse gas emissions from power plants in ten states, has been a major driver of state-level energy efficiency over the past few years. Through twelve auctions beginning in September 2008, proceeds from allowances sold total $866.4 million. Over half of these proceeds are directed to improve energy efficiency in the states. The funding streams for individual states coming from RGGI proceeds have been large enough to launch new and innovative energy efficiency programs.[57] The clean technology investments funded by RGGI led to an over $1 billion in energy savings and contributed to $2.6 billion in economic growth in the region, according to one study (Kerth and Sargent 2011). Despite the economic and environmental benefits, a handful of states have taken actions to try and pull out of RGGI and one, New Jersey, plans to withdraw January 1, 2012. In May 2011, Governor Chris Christie announced the state would no longer participate in the nation's first cap and trade program (NJ On-Line 2011). Through 2010, New Jersey had invested $29.5 million in twelve energy efficiency and renewable energy projects in the commercial and industrial sectors. A year prior, Governor Christie diverted 44% of the auction proceeds to state budget deficit reduction, an action replicated in New York and New Hampshire, which diverted 31.8% and 11%, respectfully (RGGI 2011).

Lead by Example

State governments can advance energy-efficient technologies and practices in the marketplace by adopting policies and programs to save energy in public sector buildings and fleets, a practice commonly referred to "Leading by Example" (LBE). In the current environment of fiscal austerity, LBE policies and programs are a proven strategy to improve the operational efficiency and economic performance of states' assets. Furthermore, LBE initiatives lower negative environmental and health impacts of high energy use, and promote energy conservation to the broader public.

States commonly adopt policies and comprehensive programs that to reduce energy-use in state buildings. State and local governments operate numerous facilities, including office buildings, public schools, colleges, and universities, and the energy costs to run these facilities can account for as much as 10% of a typical government's annual operating budget (EPA 2009). Only a handful of states have yet to implement a significant energy efficiency policy for public facilities. The most widely adopted measure at the state level is a mandatory energy savings target for new and existing state government facilities. The building requirements encourage states to invest in efficient new building

[57] See (RGGI 2011) for full analysis of state energy efficiency programs funded by RGGI.

construction and retrofit projects, lowering energy bills and promoting economic development in the energy services and construction sectors.

Seeking to achieve public-sector energy efficiency goals, states are taking action to implement energy-saving measures through comprehensive programs. Two critical elements of successful public-sector energy efficiency initiatives are proper energy management and institutional support for energy-savings performance contracting (ESPC), both of which help projects overcome information and cost barriers to implementation. Benchmarking energy use in public-sector buildings through tailored or widely available tools such as EPA ENERGY STAR Portfolio Manager ensures a comprehensive set of energy-use data that drives cost-effective energy efficiency investments. If the proper encouragement, leadership, and resources are in place, states can finance energy improvements through Energy Savings Performance Contracts (ESPCs), which allow the state to enter into a performance-based agreement with an Energy Service Company (ESCOs).[58] The contract allows the state to pay the ESCO for its services with money saved from installed energy efficiency measures.[59]

Aside from LBE initiatives in state government buildings, states also pursue efficient vehicle fleet policies to reduce fuel costs and create a hedge against rising fuel prices. State vehicle fleets require a considerable amount of resources, which can be targeted with LBE policies as well. State governments operate fleets of about 500,000 vehicles, ranging from about 1,000 to more than 50,000 per state. In doing so, states incur operation and maintenance costs of about $2.5 billion in total, ranging from $7 million to $250 million (NCFSA 2007). In response to this significant cost, states may adopt a definitive efficiency standard for state vehicle fleets—an optimal tool that ensures a reduction in fuel consumption and greenhouse gas emissions. Other policies may include binding goals to reduce petroleum use by certain amount over a given timeframe, meaningful greenhouse gas reduction targets for fleets, or procurement requirements for hybrid-electric or plug-in electric vehicles. In order to receive credit for the Scorecard, fleet policies must contribute to efficiency improvements that exceed existing Corporate Average Fuel Economy (CAFE) standards.

Table 23. State Scoring on Lead by Example Initiatives

State	Benchmarking Requirements for Public Buildings (0.5 points)	New and Existing State Building Requirements (0.5 point)	Efficient Fleets (0.5 point)	ESPC Policy and Programs (0.5 points)	Score
California	•	•	•	•	**2**
Delaware	•	•	•	•	**2**
Hawaii	•	•	•	•	**2**
Utah	•	•	•	•	**2**
Colorado	•	•	•	•	**2**
Connecticut	•	•	•	•	**2**
Massachusetts	•	•	•	•	**2**
Minnesota	•	•	•	•	**2**
Washington	•	•	•	•	**2**
New Hampshire	•	•		•	**1.5**
Alabama	•		•	•	**1.5**
Arizona	•	•		•	**1.5**
Arkansas	•	•		•	**1.5**
Florida		•	•	•	**1.5**
Maine		•	•	•	**1.5**
Ohio	•	•		•	**1.5**
Rhode Island		•	•	•	**1.5**
Vermont	•	•	•		**1.5**
Illinois		•	•	•	**1.5**

[58] See footnote 23 for how we define ESPC encouragement, leadership, and resources.
[59] For a full discussion of ESPCs, the ESCO market, and actual implementation trends see (Satchwell et al. 2010) and the Energy Services Coalition website: http://www.energyservicescoalition.org/

State	Benchmarking Requirements for Public Buildings (0.5 points)	New and Existing State Building Requirements (0.5 point)	Efficient Fleets (0.5 point)	ESPC Policy and Programs (0.5 points)	Score
Kentucky	•	•		•	**1.5**
New Jersey	•	•		•	**1.5**
New York	•	•		•	**1.5**
North Carolina	•	•		•	**1.5**
Oregon	•	•		•	**1.5**
South Carolina	•	•		•	**1.5**
Tennessee	•	•		•	**1.5**
Texas	•	•		•	**1.5**
Wisconsin		•	•	•	**1.5**
Mississippi	•		•	•	**1.5**
Missouri		•	•	•	**1.5**
District of Columbia	•	•			**1**
Iowa	•	•			**1**
Kansas			•	•	**1**
Louisiana		•		•	**1**
Michigan	•	•			**1**
Montana		•		•	**1**
Pennsylvania		•		•	**1**
Virginia		•		•	**1**
Alaska	•	•			**1**
Georgia	•	•			**1**
Idaho		•		•	**1**
Indiana		•		•	**1**
Maryland		•		•	**1**
New Mexico		•		•	**1**
South Dakota	•	•			**1**
Nevada		•			**0.5**
Oklahoma		•			**0.5**
Nebraska	•				**0.5**
West Virginia	•				**0.5**
Wyoming				•	**0.5**
North Dakota					**0**

Figure 11. Leading States: Lead by Example Initiatives

Hawaii: Hawaii's Lead by Example program offers a comprehensive set of services to state agencies. Aggressive policies underpin the program, which include a benchmarking requirement that all state agencies evaluate the energy efficiency in existing buildings of qualifying size and energy characteristics. Each agency must identify opportunities for increased energy efficiency by setting benchmarks for these buildings using ENERGY STAR Portfolio Manager or another similar tool. As a result of Hawaii's LBE program, during fiscal year 2009, total state agency electric consumption dropped 5.8% from 2008 and 2.5% from the baseline year of 2005. It is estimated that the savings in 2009 electricity consumption translated to savings of $10 million in general funds.

Minnesota: Over the past decade, the state of Minnesota has shown its commitment to sustainable buildings by providing leadership, setting high performance standards, and putting forward an integrated framework of programs that provide a comprehensive system for designing, managing, and improving building energy performance. Beginning with aggressive standards for state buildings based on the long-term goal of having a zero-carbon building fleet by 2030, the state offers a complementary benchmarking program for tracking energy use, and the Public Building Enhanced Energy Efficiency Program that aids in the implementation of retrofits. Minnesota also requires on-road vehicles owned by state departments to reduce gasoline consumption by 25% by 2010 and by 50% by 2015. Also, at least 75% of purchases of new on-road vehicles must have fuel efficiency rating that exceeds 30 mpg for city usage and 35 mpg for highway usage.

Research, Development, and Demonstration (RD&D)

Research, development, and demonstration programs drive advancements in energy-efficient technologies and states play a unique role in laying the foundation for such progress. By leveraging resources in the private and public sector, state governments can foster collaborative efforts that achieve the goals of rapidly creating, developing, and commercializing new, energy-efficient technologies.

In response to the increasing need for state initiatives in energy-related RD&D, several state energy research, development, and demonstration institutions established the Association of State Energy Research and Technology Transfer Institutions (ASERTTI) in 1990. Members of ASERTTI collaborate on applied RD&D and share technical and operational information with a strong focus on end-use efficiency and conservation. In addition to providing a variety of services to create, develop, and deploy new technologies for energy efficiency, state RD&D efforts can address a number of market failures that exist in the energy services marketplace that impede the diffusion of new technologies (Pye and Nadel 1997).

Aside from those affiliated with ASERTTI, numerous other state-level entities conduct research, development, and demonstration programs. A diverse set of institutions (including universities, state governments, research centers, and utilities) fund and implement RD&D programs for the purpose of energy efficiency. Such programs include research on energy consumption patterns in local industries, development of energy-saving technologies at state or university research centers, and demonstration through public/private partnerships.

Individual state research institutions provide expertise and knowledge to their states from which policymakers can draw in order to advance successful efficiency programs. Through research and development, they also provide the impetus for commercial investment and manufacturing of the new technologies that these institutions conceive. Additionally, these research institutions provide valuable knowledge spillovers to other states through the sharing of information—which is facilitated through membership with ASERTTI, allowing states to benefit from other states' research. States without these institutions can then use this shared information as a roadmap in order to advance their own efficiency programs.

Table 24. State Scoring on RD&D Programs

State	Major RD&D Programs	Score
Alaska	The Cold Climate Housing Research Center, The Alaska Housing Finance Corporation Research Information Center (RIC), and the Emerging Energy Technology Fund	2
California	The California Energy Commission's Public Interest Energy Research (PIER)	2
Iowa	The Iowa Energy Center	2
Massachusetts	Massachusetts Energy Efficiency Partnership (MAEEP), deep energy retrofit and behavioral pilot programs; High Performance Green Building Grants	2
Michigan	Michigan NextEnergy Center	2
New York	New York State Energy Research and Development Authority (NYSERDA)	2
North Carolina	The North Carolina Green Business Fund and NC Solar Center	2
Oregon	The Oregon State University Energy Efficiency Center, University of Oregon Energy Studies in Building Laboratory, and The Energy Trust of Oregon	2
West Virginia	Energy Efficiency Center of West Virginia and the West Virginia University Building Energy Center	2
Wisconsin	Energy Center of Wisconsin and Wisconsin Focus on Energy	2
Colorado	Clean Energy SuperClusters at Colorado State University	1
Florida	Florida Solar Energy Center	1
Minnesota	The Conservation Applied Research & Development (CARD) Fund	1
New Jersey	The New Jersey Commission on Science and Technology (CST) administers the Edison Innovation Clean Energy Fund	1

New Mexico	The Energy Innovation Fund, managed by the Energy, Minerals and Natural Resources Department	**1**
Ohio	Ohio Air Quality Development Authority (AQDA) Advanced Energy Program Grants and Energy Industries of Ohio	**1**
Tennessee	University of Tennessee partnerships with Oak Ridge National Laboratory and Electric Power Research Institute. Energy efficiency technologies eligible for Tennessee's emerging industry tax credit	**1**
Texas	The Texas A&M Energy Systems Laboratory (ESL)	**1**
Vermont	Efficiency Vermont research studies on cost-effective efficiency opportunities	
Virginia	Modeling and Simulation Center for Collaborative Technology	**1**
Delaware	Two RD&D grant programs run through the Green Energy Fund	**0.5**
Georgia	Funded in part by Georgia Environmental Finance Authority, Southface conducts research and training on energy efficient housing and communities	**0.5**
Hawaii	The Transportation Energy Transformation Program	**0.5**
Illinois	The University of Illinois at Chicago Energy Resources Center	**0.5**
Indiana	The Indiana Office of Energy Development (OED)	**0.5**
South Dakota	South Dakota State University Energy Analysis Laboratory	**0.5**

Note: See Appendix B for expanded descriptions of state energy efficiency RD&D program activities.

Figure 12. Leading States: State Research, Development, and Demonstration Initiatives

New York: The New York State Energy Research and Development Authority is the epitome of an effective and influential research and development institution. Its RD&D activities are primarily funded through various charges on state ratepayers. The RD&D efforts include a wide range of energy efficiency and renewables programs, organized into seven primary program areas: Energy Resources, Transportation and Power Systems, Energy and Environmental Markets, Industry, Buildings, Transmission and Distribution, and Environmental Research. NYSERDA's 2009/10 RD&D budget was approximately $165 million.

Michigan: The state of Michigan has taken major steps in recent years to re-tool its manufacturing industry and become a hub for the research, development, and demonstration of clean energy technology. A centerpiece to this effort, the Michigan NextEnergy Center hosts laboratories, business incubator space, and other facilities to support the state's alternative energy industry. Energy efficiency and battery storage are central to the NextEnergy Center. As a Renaissance Zone, businesses within the NextEnergy Center may be eligible for tax benefits aside from the numerous tax credits the state offers alternative energy businesses.

CHAPTER 6: APPLIANCE AND EQUIPMENT EFFICIENCY STANDARDS

Author: Max Neubauer

Background

Every day in our homes, offices, and public buildings, we use appliances and equipment that are less energy efficient than other available models. While the usage and energy cost for a single device may seem small, the extra energy consumed by less efficient products collectively adds up to a significant amount of wasted energy. For example, one battery charger may draw a small amount of electricity and waste an even smaller amount. However, with more than 1.7 billion battery chargers in the U.S., the total amount of energy wasted is significant. Real and persistent market barriers, however, inhibit sales of more efficient models. Appliance efficiency standards overcome these barriers by requiring manufacturers to meet minimum efficiency levels for all products, therefore removing the most inefficient products from the market.

States have historically led the way when it comes to establishing standards for appliances and other equipment. California was the first state to introduce appliance standards in 1976. Many states, such as New York and Massachusetts, followed soon after. The federal government did not institute any national standards until 1988 through the passing of the National Appliance Energy Conservation Act of 1987, which created national standards based on those that had been adopted by California and several other states. Congress enacted additional national standards in 1988, 1992, 2005, and 2007. In general, these laws set initial standards for products and require the U.S. Department of Energy to review and strengthen standards on a specific standard. All told, about 45 products are now subject to national efficiency standards.

In February 2009, President Obama signed a Presidential Memorandum that, over the next four years, will require the introduction or update of standards for twenty-six products. To date, DOE has set or updated more than twelve standards and currently has about fifteen rulemakings in progress. When DOE rulemaking activity picks up, the impetus for states to set standards decreases. Conversely, when the national standard-setting process lags, activity in the states increases, serving as a catalyst for national standards. We find ourselves in the former category today. Unsurprisingly, this uptick in DOE activity coincides with just one state – Connecticut – passing standards legislation in 2011.

Federal preemption generally prevents states from setting standards stronger than existing federal requirements for a given product. Under the general federal preemption rules applied by the Energy Policy Act of 2005 (EPAct) and the Energy Independence and Security Act of 2007 (EISA), states that have set standards prior to federal enactment may enforce their state standards up until the federal standards become effective; states that have not yet set standards are preempted immediately. States that wish to implement their own standard after federal preemption must apply for a waiver; however, states remain free to set standards for any products that are not subject to national standards.

Methodology

Acknowledging the cyclical and changing standards landscape, we lowered the maximum number of points for standards this year from 3 to 2, in light of the fact that most standards (new and updates to existing) are being advanced at the federal rather than the state level. A state can earn up to 2 points for adoption of appliance efficiency standards. We score states based on the potential savings in billion Btus (BBtu) generated through 2030 by appliance efficiency standards not presently preempted by federal standards. The savings estimates, which are based on an analysis by the Appliance Standards Awareness Project (ASAP) and ACEEE (Neubauer et al. 2009), are normalized based on the number of residential customers in the state so that each state is ranked on the amount of

savings generated per customer. Each state earns a score of 0 to 2 in increments of half (0.5) points. See Table 25 for the scoring methodology.

Table 25. Scoring Methodology for Savings from Appliance Standards

Energy Savings per Customer through 2030 (BBtu/customer)	Score
≤ 100	**2**
50 ≤ x < 100	**1.5**
10 ≤ x < 50	**1**
0 < x < 10	**0.5**
0	**0**

Table 26. State Scoring for Appliance Efficiency Standards

States	Energy Savings per Customer through 2030 (BBtu/customer)	Date Most Recent Standards Adopted	Score
California***	122	2010	2
Nevada**	76	2007	2
Connecticut	29	2011	1
Massachusetts*	7.3	2005	1
New York	9.4	2010	0.5
Arizona	7.7	2009	0.5
Oregon	3.1	2007	0.5
Washington	1.2	2009	0.5
District of Columbia	0.6	2009	0.5
Maryland	0.5	2007	0.5
Rhode Island	0.5	2006	0.5
New Hampshire	0.4	2008	0.5
Georgia***	NA	2010	0.5
Vermont	0	2006	0
New Jersey	0	2005	0
Texas***	NA	2010	0

Sources: Neubauer et al. 2009; ASAP website as of September 2011

* Note: In addition to standards enacted in Massachusetts, the state earns a half a point for having developed a waiver of federal standards for gas furnace minimum efficiency.

** Note: Nevada earns half a point for advancing standards for general service incandescent lamps that are more stringent than the federal standards. California would earn an additional half point as well, but it has already been awarded the maximum number of points possible.

***Georgia and Texas passed standards on plumbing products in 2010, as did California in 2007, which include toilets, urinals, faucet aerators, showerheads, and commercial pre-rinse spray valves. However, the CA and TX standards for faucet aerators, showerheads, and spray valves are only as stringent as the existing federal standard and therefore we do not award them credit for energy savings. Georgia's standard exceeds the existing federal standard, but since no analysis has yet been completed measuring the potential savings, we awarded the state half a point assuming that the savings would at least be greater than zero.

California, scoring a maximum of 2 points, continues to take the lead on appliance efficiency standards, most recently adopting the first-ever standards for televisions. Not only has California enacted the greatest number of standards, most other states' standards are based on California's, such as the television standards passed in Connecticut this year. Many of the current state standards have now been included in pending federal legislation; thus, without future state initiative to develop

and implement standards for additional products, the number of state standards preempted by federal standards will likely increase.

It is worth noting that the standards passed for plumbing products by California, Georgia, and Texas, which include standards for toilets, urinals, faucet aerators, showerheads, and commercial pre-rinse spray valves, will generate a significant volume of water savings. The energy savings come from the reduced need for hot water as well as the energy required to treat wastewater. These standards are particularly important in these three states, which have been experiencing frequent and persistent droughts in their regions at an increasing rate over the last decade or so.

Figure 13. Leading States: Appliance and Equipment Efficiency Standards

Connecticut: In January 2011, the Connecticut General Assembly passed Bill 1243, which added standards for compact audio players, televisions, and DVD players and recorders. The standards are based on standards from Title 20 of the California Code of Regulations, making Connecticut only the second state to pass statewide standards on televisions. The standards are set to become effective in January 2014.

***Nevada*:** In June 2007, the Nevada General Assembly adopted Assembly Bill 178, codified as NRS 701.260, establishing standards for general purpose lights sold in the state of Nevada. Beginning January 1, 2012, no general purpose light may be sold in the state unless it produces at least 25 lumens per watt of electricity consumed. This requirement will make the Nevada standard more stringent than the federal standard, precluding a number of bulbs within each wattage category and correlating lumen range from being sold in the state.

CHAPTER 7: MEASURING PERFORMANCE IN STATE ENERGY EFFICIENCY: RESIDENTIAL SECTOR

Authors: Colin Sheppard, Arne Jacobson and Charles Chamberlin (Schatz Energy Research Center, Humboldt State University), Yerina Mugica (Natural Resources Defense Council).

Note: Findings from this chapter are not included in the overall state rankings of this report, but rather as an exploratory exercise in measuring energy consumption trends as a means to understanding energy efficiency.

Summary

In this chapter, we present and discuss a methodology for an aggregate, state-level metric of energy consumption intensity (ECI) in the residential sector and provide summary results for each of the 50 states. The methodology identifies changes in state energy consumption intensity (i.e. energy consumption per capita) after adjusting for changes due to year-to-year variations in weather.

This research indicates that it is possible to track trends in state energy consumption intensity, even with the imperfect data sets that are currently available. With improvements in the data collection process, the approach could be further strengthened into a powerful tool for evaluating states' progress in reducing energy consumption.

Acknowledgements

This chapter is the result of an analysis completed by the authors and commissioned by the Center for Market Innovation at the Natural Resources Defense Council. A detailed report about a performance based state energy efficiency metric that could be used to increase transparency and accountability of energy efficiency performance among states and potentially to reward states for improved performance can be downloaded at the following Web site: http://www.schatzlab.org/projects/psep.

Measuring Performance

Our approach for tracking energy consumption intensity (ECI) is based upon per capita energy consumption data for the residential sector in each state over a period of 10 years. We use the results of a regression analysis to adjust ECI in a given year for changes in residential heating and cooling energy use due to annual variations in state weather. We call this corrected value the adjusted energy consumption intensity (aECI). In order to evaluate a state's performance in reducing aECI, we estimate the slope of a linear trend through the ten years including the test year and the nine preceding years. States with a downward (negative) slope are considered to have achieved progress, while those with a flat or increasing slope are not. The following section, "Methodological Approach", describes this methodology in further detail.

Table 29 presents a ranking of states based on the slope of aECI for the four most recent periods for which data are available (1997-2006, 1998-2007, 1999-2008, 2000-2009). When the ten-year slope of aECI is recalculated on an annual basis, there is considerable overlap from period to period in the data used to create the metric. The four periods shown in Table 29 illustrate the variability and evolution of states' performance year over year.

Table 29. Ten-Year Slopes of aECI from 1997-2006, 1998-2007, 1999-2008, and 2000-2009

	2006		2007		2008		2009	
Rank	State	Slope	State	Slope	State	Slope	State	Slope
1	WA	-0.27	WA	-0.37	MA	-0.53	MA	-0.76
2	CA	-0.19	MA	-0.31	WA	-0.52	WA	-0.56
3	UT	-0.08	CA	-0.20	TX	-0.35	TX	-0.56
4	IL	-0.02	TX	-0.18	OR	-0.26	MI	-0.54
5	TX	0.01	OR	-0.11	NY	-0.19	NY	-0.46
6	OR	0.02	UT	-0.05	RI	-0.19	RI	-0.44
7	MA	0.07	KS	-0.03	UT	-0.17	CT	-0.40
8	NY	0.15	IL	-0.02	MI	-0.16	DE	-0.38
9	SD	0.16	NY	0.00	CA	-0.16	ME	-0.33
10	NE	0.18	RI	0.00	IL	-0.09	PA	-0.32
11	RI	0.19	NH	0.03	MD	-0.07	OR	-0.32
12	NJ	0.20	NE	0.08	KS	-0.04	MD	-0.31
13	NV	0.21	MD	0.13	NE	-0.03	GA	-0.28
14	HI	0.23	MI	0.18	DE	-0.01	IL	-0.27
15	KS	0.25	NJ	0.20	CT	0.01	AK	-0.24
16	MD	0.26	SD	0.20	NH	0.03	NE	-0.21
17	IA	0.28	NV	0.22	AK	0.04	NH	-0.20
18	OH	0.35	HI	0.23	PA	0.04	UT	-0.18
19	NH	0.36	IA	0.25	NJ	0.05	MN	-0.18
20	LA	0.37	GA	0.28	NV	0.07	NJ	-0.11
21	MI	0.40	MS	0.28	GA	0.08	AL	-0.11
22	NC	0.43	LA	0.29	MN	0.12	MS	-0.10
23	SC	0.44	SC	0.30	MS	0.12	NC	-0.07
24	IN	0.46	NC	0.31	SC	0.15	NV	-0.07
25	PA	0.47	PA	0.34	NC	0.16	CA	-0.06
26	GA	0.47	OH	0.34	AL	0.17	WI	-0.05
27	TN	0.47	OK	0.36	OH	0.18	SC	-0.05
28	AZ	0.49	DE	0.36	IA	0.18	OH	-0.03
29	OK	0.50	AL	0.36	LA	0.19	FL	-0.03
30	MS	0.51	TN	0.37	SD	0.20	CO	0.00
31	AR	0.52	AR	0.38	ME	0.21	KS	0.01
32	MN	0.55	FL	0.42	FL	0.23	TN	0.03
33	KY	0.60	MN	0.42	AR	0.24	IN	0.09
34	AL	0.60	AZ	0.43	WI	0.24	LA	0.12
35	FL	0.61	WI	0.45	HI	0.25	AR	0.13
36	ID	0.61	IN	0.46	TN	0.26	OK	0.16
37	WI	0.62	CT	0.52	CO	0.29	IA	0.19
38	MO	0.66	ME	0.55	IN	0.33	VA	0.23
39	VA	0.67	CO	0.56	AZ	0.36	AZ	0.24
40	AK	0.69	KY	0.60	OK	0.36	SD	0.24
41	CO	0.70	AK	0.61	KY	0.44	KY	0.24
42	DE	0.71	MO	0.63	VA	0.49	HI	0.33
43	NM	0.76	VA	0.66	MO	0.56	MO	0.34
44	CT	0.83	ID	0.69	ID	0.64	VT	0.44
45	VT	0.97	VT	0.74	VT	0.65	ID	0.61
46	ME	1.07	NM	0.76	NM	0.70	NM	0.69
47	WY	1.11	ND	1.32	ND	1.07	ND	0.81
48	MT	1.22	WY	1.37	WY	1.41	WV	1.23
49	ND	1.35	WV	1.57	WV	1.48	WY	1.33
50	WV	1.47	MT	1.58	MT	1.60	MT	1.57

Figure 13 presents a graphical display of the results from 2000-2009. This metric allows the ranking of states to be based upon recent reductions in their aECI. In other words, states are rated relative to their own baseline; this approach gives every state the opportunity to rise in the rankings.

Figure 13. Ten-Year Slope of Adjusted ECI from 2000-2009 for U.S. States

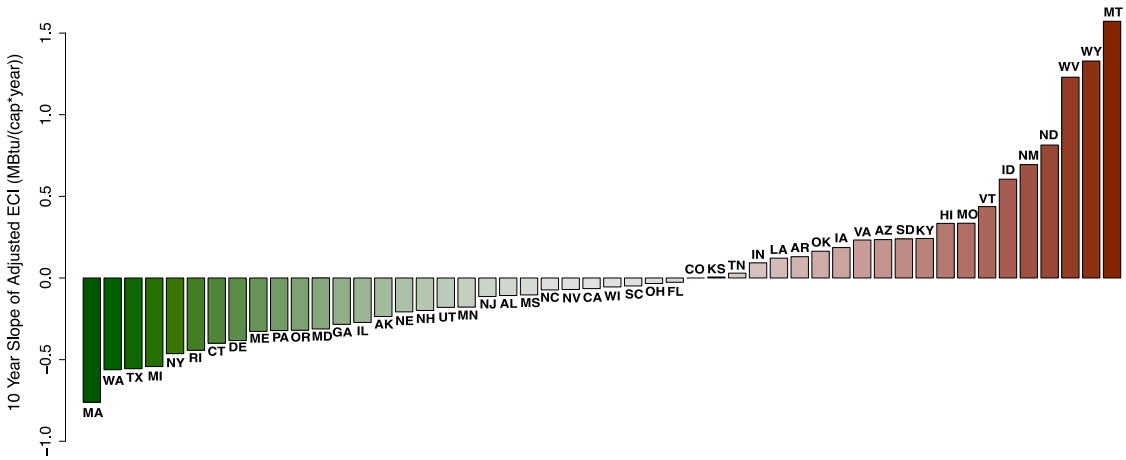
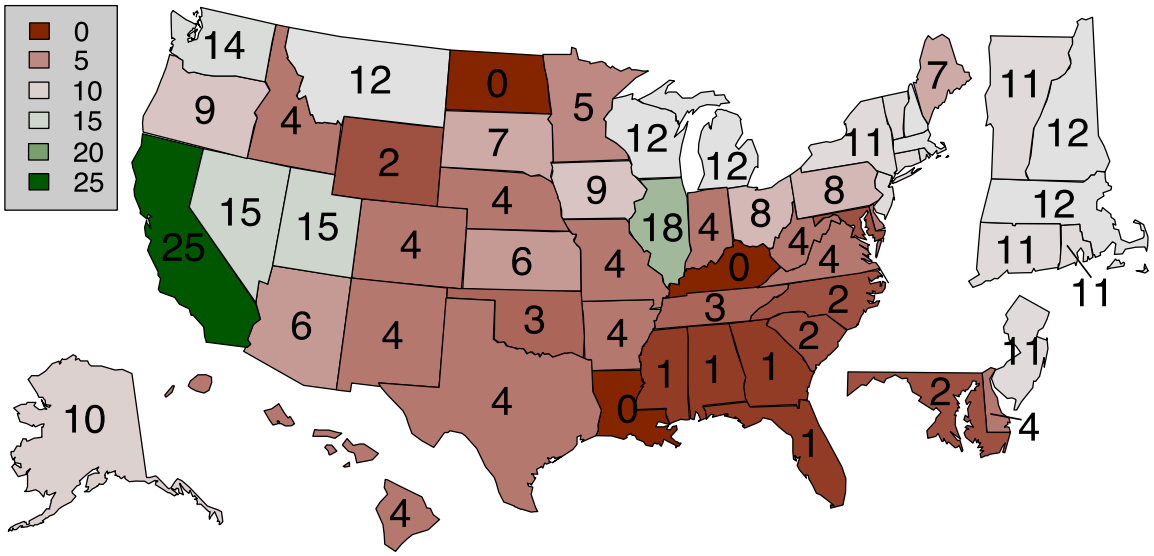


Figure 14 summarizes the historical performance of the states when this metric is applied to the twenty five ten-year periods from 1976-1985 to 2000-2009; it presents the total number of years in which the ten-year slope of aECI was negative for each state. The states with the largest number of negative slopes are the ones that have consistently decreased their aECI over the time period.

Figure 14. Summary of the Number of 10-year Periods from 1985-2009 in which the Slope of aECI was Negative



Methodological Approach

The approach that we employ for tracking ECI begins with aggregate energy consumption data for the residential sector in each state over a period of 10 years.[60] These data are adjusted according to state population, yielding annual per capita residential energy consumption intensity (MBtu/capita/year). The data are also corrected for an unrealistic assumption made by the EIA that primary energy associated with electricity consumption should be estimated using a national averaged fossil fueled heat rate. Our analysis estimates a state specific heat rate based on the composition of electricity production, which assumes no conversion losses from renewable electricity,[61] hydropower, and nuclear power.[62]

While there are many causes for variation in energy consumption intensity, weather is most clearly beyond the influence of policy makers[63]. Therefore, adjusting for this factor is an important step in the evaluation of consumption trends that result from policy changes. We perform a fixed effect multiple linear regression to determine the response of ECI to heating and cooling degree days (HDD and CDD), both strong indicators of the impact of climate on building energy consumption. The regression includes dummy coefficients to model the fixed differences in ECI from state to state as well as differences from year to year across all states. The estimated weather coefficients are used to adjust ECI in a given year to a normal weather year based on the state's 30-year average HDD and CDD values.[64]

The result is an adjusted residential sector ECI (hereafter called "aECI") time series for each state that includes corrections for changes in residential heating and cooling energy use due to annual variations in state weather. In order to evaluate a state's performance in reducing aECI, we estimate the slope of a linear trend line through the ten years including the test year and the nine preceding years. The PSEP score for the year equals this slope. States with a downward (negative) slope, which indicates a decrease in aECI, are considered to have achieved progress, while those with a flat or increasing slope are not.[65]

The performance based metric for evaluating states' progress that is described in this chapter differs from the ACEEE scorecard for state energy efficiency policy in some important ways. First, there are differences in the sectors that are currently covered by the respective approaches. For instance, the ACEEE scorecard includes an evaluation of residential, commercial, and transportation sector policies, while the performance based metric presented here focuses exclusively on the residential sector. Additionally, while the ACEEE scorecard gives credit to states immediately for enacting efficiency oriented policies, a performance based approach gives credit only after those policies have delivered results in terms of reductions in energy consumption intensity over time. As a result, there is an inherent time lag between policy and performance based evaluation approaches. Moreover, with a performance based approach states will not receive credit for enacting efficiency oriented policies unless those policies result in measurable reductions in weather adjusted energy

[60] The energy data are from the Energy Information Agency of the U.S. Department of Energy's State Energy Data System (SEDS). Population data are from census and annual intercensal estimates from the U.S. Department of Commerce, Bureau of the Census.
[61] We treat the following as renewable sources of electricity: wind, solar, wood, geothermal, municipal waste.
[62] Because the grid mix in each state changes from year to year, the heat rate estimate also changes. However, we seek to separate the impact on consumption of energy efficiency measures from changes in grid mix or conversion efficiency. To address this issue, we use a constant state-specific heat rate for any given evaluation period. For example, if our metric is concerned with ECI trends in California for the period 2000-2009, then we use the average heat rate over that period to make the adjustment to primary energy associated with electricity consumption.
[63] Other factors typically used in this kind of analysis include economic indicators and the price of energy. See the section below titled "PSEP vs. Other Econometric Approaches" for further discussion of our decision not to adjust for these factors.
[64] State level, population weighted HDD and CDD values are not currently published for Alaska and Hawaii by the NDCD. Our methodology for estimating these values from 1975-2008 is described in Appendix D of our broader report: http://www.schatzlab.org/projects/psep/psep.php
[65] It is also possible to add the condition that the slope estimate for a given test period be negative with some level of confidence. This can decrease the occurrence of false positives, that is, exclude states that actually made no improvement in aECI from our definition of progress. In our broader report, we apply such a hypothesis test at the 80% significance level.

consumption intensity. Finally, as described in more detail in the "Key Conclusions" section below, the data currently reported for energy consumption by state are not perfect. This may influence some of the results in the current assessment of performance based results. As a result of these differences, it is not surprising that in some cases, states' rankings under the performance metric presented in this chapter do not match those in the ACEEE scorecard. Importantly, the approaches can be used to complement each other, as one is a measure of state energy efficiency policy while the other is a measure of progress in achieving reductions in energy consumption intensity.

Notable Results

Some of the results presented above are especially notable, including the nationwide trend toward better (more negative) PSEP scores, as well as the particular performance of a few individual states.

From 2006 through 2009, the general trend in the PSEP metric has been toward lower scores, or better overall performance. As can be seen in Table 29, the number of states with negative PSEP scores increases from 4 to 29. One might conclude that these reductions in consumption can be attributed to the recent economic downturn. Indeed, in 2008 and 2009, residential aECI has generally decreased from its 2007 value for most states. However, this change is never precipitous or outside the bounds of normal variability.

Additionally, we conducted an experiment to see if including an economic indicator as a correction factor in the ECI adjustment would change the results. When real household disposable income is used in addition to heating and cooling degree days to adjust residential ECI, the resulting PSEP metric shows an almost identical overall downward trend across all states between 2006 and 2009. We believe that the observed trend is primarily a result of other effects, such as state and national efficiency policies, the price of energy, and/or structural changes in the residential sector.

The states of Connecticut, Maine, and Delaware stand out as states that have demonstrated dramatic improvements in both their PSEP score as well as their ranking amongst the 50 states from 2006 to 2009. Similar to the nationwide trend toward better performance, these results are most likely attributable to state level policies (Connecticut and Maine rank high by their ACEEE scores) as well as price spikes (the sharp rise in petroleum prices has coincided with a steep reduction in the consumption of fuel oil for home heating in all three states) and, to a lesser extent, the 2008 recession.

Finally, it should be noted that California has fallen in its PSEP rankings from second place in 2006 to twenty-fifth in 2009. This drop is partially due to a flattening of California's aECI trend, which may indicate that many of the low-cost efficiency opportunities have already been realized in California's residential sector.[66] However, most of the drop in rank can be explained by successes in other states catching up to and exceeding California's recent performance.

PSEP vs. Other Econometric Approaches

Other econometric approaches commonly cited in academic and policy literature (see Bernstein et al., 2003; Loughran and Kulick, 2004; Horowitz, 2011) focus on quantifying the impact of specific policies (or groups of policies) on energy consumption. They are usually based upon a regression analysis which includes all relevant explanatory variables that are completely (or mostly) policy-independent (e.g. energy prices as well as economic and demographic indicators). The technical approach involves comparing the actual consumption trends to a *counterfactual*, or a prediction of what the trend would have been in the absence of policies or other factors not accounted for in the regression model. While this approach can be used successfully to discern the impact of specific policies, the general applicability of the scheme is somewhat limited.

[66] The authors of this Chapter conducted a detailed analysis of California's residential sector energy consumption and efficiency policy history, see the California Ground Truth Analysis report at:
http://www.schatzlab.org/projects/psep/psep.php

The problem lies in the fact that a counterfactual model must be estimated from a time period before the introduction of the policy, while the evaluation of performance must occur in the time period after implementation. With careful application, this can be done for specific policy regimes within individual states or even across states with very similar policies and timelines, but it would be very difficult – if not impossible – to apply this methodology in a consistent manner to all 50 states *every* year due to the cacophony of policies that come and go over time, many of which have overlapping influence on energy consumption. So while the counterfactual approach is admittedly more discerning than the PSEP metric, the approach should be seen as a solution to a different set of objectives.

The PSEP metric was developed with the primary objective of instigating a national dialogue about tracking energy efficiency performance at the state level. The technical approach was designed to be all-inclusive. Changes in energy consumption occur for a multitude of reasons, but only those that are totally beyond the influence of state policymakers (i.e. weather) are controlled for in the analysis. Other factors (in particular, energy prices as well as economic and demographic indicators) are not a part of the correction process. The following sections discuss the rationales for these choices in more detail.

Energy Prices

It is well known that consumers often respond to price signals by using less energy when prices are high and more when they are low. It is unsurprising, therefore, that Bernstein et al. (2003) and others have observed a significant correlation between residential energy consumption and the logarithm of electricity and natural gas prices.

While this may suggest that the ECI values should be adjusted for year-to-year variations in electricity, natural gas, and other associated prices, PSEP does not make this adjustment because it might negate state efforts to reduce residential energy consumption by means of tiered billing that involves higher rates for higher levels of consumption. Although changes in prices due to other 'non-policy' related factors (e.g., speculation in the market, interruptions in supply, actual resource constraints, etc.) would also cause variation in energy consumption, it is difficult to separate these price effects from policy induced price changes. With all of this in mind, the question of whether adjustments should be made for variations due either to regulatory-induced or market-induced changes in prices is an important one. Because of this, we decided against making such adjustments, since policy driven price variation provides a natural and powerful tool to produce reductions in residential energy intensity.

Economic Factors

Bernstein et al. (2003) observed strong sensitivity in residential energy consumption per capita to various demographic and economic factors such as the logarithms of average household size, real disposable income per capita, and employment per capita.

State employment and disposable income are not factors that states can easily manipulate to reduce energy consumption. As such, they are reasonable candidates for factors with which to adjust year-to-year energy consumption. However, we question whether increases in consumption that are due to increases in disposable income should be excluded from a state's performance indicator. Why reward some states for a temporary economic boom if they are actually increasing their per capita energy consumption? Moreover, a decrease in energy consumption that accompanies an economic downturn may be unintentional, but it still represents a decrease, however temporary. States that do not have an effective set of energy efficiency programs or policies in place would not be well positioned to sustain reductions, so any "unearned" recognition would be short lived. Further, adding adjustments for disposable income provided only modest improvements in explaining the year-to-year variation in state ECI. For these reasons, we ultimately chose not to adjust for disposable income or any other economic factor.

Key Considerations and Conclusions

The analyses that we have conducted indicate that it is possible to track trends in residential ECI by state. Although ECI trends can be tracked, the method, by design, does not isolate changes in ECI that are solely due to policy choices from changes due to other factors. However, while we were not able to explain all of the year-to-year variability in the ECI with this approach, including additional policy independent variables (e.g. disposable income, percent employment, GDP by state, etc.) did not dramatically improve the results. Therefore, while no metric can isolate changes due to policy with 100% reliability, we believe this methodology is a reasonable approach to gauge policy impacts over the long term. Notably, a preliminary analysis of commercial sector data indicates that it may be possible to extend the use of the performance based ECI metric to the commercial sector, although access to improved data would be required to achieve this.

Almost all of the data used in the analyses in this report are from the EIA State Energy Data System (SEDS). The data for SEDS are self-reported by utilities and electric power generating plants, and the sectoral classifications (i.e., residential, commercial, etc.) are based on the supplier classification of accounts and may vary by supplier, by state, and by year. In order to more accurately track state level trends in energy efficiency, we recommend the following improvements in data collection and reporting:

1. Standardize and Disaggregate SEDS Classification System: For ideal implementation of the proposed program, the classification system associated with SEDS should be standardized across all states and suppliers.
2. Quarterly Energy Consumption and HDD/CDD Data: If quarterly, not just annual, energy consumption data were available the statistical power of the proposed analysis would be increased substantially.
3. Implement System to Improve Reliability of Data reported through SEDS: assessing and improving the reliability of the self reported data from utilities and electric power generating plants is important to accurately tracking consumption trends and ultimately designing effective energy efficiency policies and programs.
4. Population Weight HDD and CDD using Current Year Populations: Currently, HDD and CDD values are weighted by the decennial census population data, this should be changed to use annual population estimates.
5. Publish Population Weighted HDD and CDD for the states of Alaska and Hawaii: Currently, the NCDC do not make estimates of annual HDD and CDD available for these states. While stand-in estimates can be made based on available data, the NCDC should include these states in their product to ensure that a consistent methodology is used.
6. Publish Consumption-Based Grid Mix Data: Estimating the mix of generation types on the electricity grid would ideally be based on electricity consumption in each state rather than on energy production. The current SEDS data only allow for production-based estimates for each state, with no accounting for imports and exports.
7. Establish Clear Leadership and Coordination across Agencies: At present, the data required for this analysis are collected by a wide range of agencies, including the EIA, NCDC, and Census Bureau. All of the contributing agencies should explicitly be made responsible for providing their portion of the data on a timely basis and should be funded so they can do so.
8. Improve Timeliness of Data Reporting: For the state energy consumption tracking system to be effective and have its desired influence, the interval between the end of the reporting period and the release of the tracking results should be as brief as practical (e.g., 6-12 months).

To successfully implement these changes, the EIA and other agencies will require modest funding increases in order to cover costs associated with additional data collection and processing.

CHAPTER 8: DISCUSSION OF SCORECARD RESULTS

The results of the *Scorecard* are presented again in Table 30 and the last column shows the state's change in ranking compared to the *2010 Scorecard*. Readers should note an important caveat: changes in state rankings are due to *both* changes in the scoring methodology as well as changes in state efficiency programs and policies. We present here some key highlights on changes in state rankings, discuss the notable states making new commitments to energy efficiency over the past year, and suggest further areas of research for future editions of the *Scorecard.*

Table 30. Summary of Overall State Scoring on Energy Efficiency

Rank	State	Utility and Public Benefits Fund Efficiency Programs and Policies Score	Transportation Score	Building Energy Code Score	Combined Heat and Power Score	State Government Initiatives Score	Appliance Efficiency Standards Score	Total Score	Change in Rank from 2010	Change in Score from 2010
Maximum Possible Points:		*20*	*9*	*7*	*5*	*7*	*2*	*50*		
1	Massachusetts	18.5	7	7	5	7	1	45.5	1	3
2	California	17.5	8	7	4	5.5	2	44	-1	-1.5
3	New York	15	6	6	4	6.5	0.5	38	1	3.5
4	Oregon	13.5	6	7	4	6.5	0.5	37.5	-1	0.5
*5	Vermont	19	4	5	3	3	0	34	0	1
*5	Washington	13.5	6	7	4	3	0.5	34	1	2
*5	Rhode Island	18.5	5	5	3	2	0.5	34	2	5
*8	Minnesota	18	2	4	3	6	0	33	0	5
*8	Connecticut	12	6	5.5	5	3.5	1	33	0	5
↑10	Maryland	9.5	7	5.5	4	4	0.5	30.5	6	6.5
11	Iowa	14	1	5	2	5	0	27	1	2.5
*12	Maine	10.5	4	4.5	5	2.5	0	26.5	-2	-0.5
*12	Hawaii	12	3	5	3	3.5	0	26.5	0	2
*12	Colorado	11	2	3.5	4	6	0	26.5	7	4.5
15	New Jersey	8.5	5	4.5	4	3.5	0	25.5	-3	1
16	Wisconsin	11.5	1	5	4	3.5	0	25	-5	-1
*17	Utah	12	1	5.5	3	3	0	24.5	-5	0
↑*17	Illinois	9	3	5	4	3.5	0	24.5	8	6
↑*17	Michigan	10	2	4.5	3	5	0	24.5	10	7
*17	Arizona	11.5	4	3	3	2.5	0.5	24.5	1	1.5
21	New Hampshire	10.5	0	5.5	3	4.5	0.5	24	1	2.5
*22	Nevada	11.5	0	5	3	1.5	1.5	22.5	-3	0.5
*22	District of Columbia	6	4	5.5	4	2.5	0.5	22.5	-3	0.5
24	Ohio	8.5	0	4	5	4.5	0	22	3	4.5
25	Pennsylvania	4	4	5	4	4	0	21	-9	-3
26	Idaho	9	0	6	2	3	0	20	0	2
*27	Florida	3.5	5	5.5	2	3	0	19	3	2
*27	North Carolina	4.5	0	5	4	5.5	0	19	-3	-1
*27	New Mexico	5	2	4.5	4	3.5	0	19	-5	-2.5
↑30	Tennessee	2	4	4	3	5.5	0	18.5	5	7.5
31	Delaware	2.5	3	4.5	3	4.5	0	17.5	-4	0
32	Indiana	6.5	0	4	3	3.5	0	17	-1	0.5

Rank	State	Utility and Public Benefits Fund Efficiency Programs and Policies Score	Transportation Score	Building Energy Code Score	Combined Heat and Power Score	State Government Initiatives Score	Appliance Efficiency Standards Score	Total Score	Change in Rank from 2010	Change in Score from 2010
33	Texas	3	0	4.5	4	4	0	15.5	-1	1
34	Virginia	2	1	5	3	3	0	14	0	2.5
35	Montana	4.5	0	5.5	1	2.5	0	13.5	-2	-0.5
36	Georgia	1.5	2	6.5	0	2.5	0.5	13	1	3
37	Kentucky	3.5	0	4.5	1	3	0	12	-1	1.5
*38	Alaska	0	1	2	2	6	0	11	-1	1
*38	Arkansas	5.5	0	2.5	1	2	0	11	3	3.5
↑40	Nebraska	1.5	0	5	1	2.5	0	10	7	6
40	Louisiana	2.5	1	4	0	2.5	0	10	2	3
42	South Dakota	4.5	0	0	3	2	0	9.5	-3	0
↑43	Alabama	2.5	0	4.5	0	2	0	9	6	6
*44	Missouri	2.5	0	2	1	3	0	8.5	-1	2.5
*44	West Virginia	0	1	3	2	2.5	0	8.5	-1	2.5
46	South Carolina	1.5	0	3	1	2.5	0	8	-6	-0.5
47	Oklahoma	2.5	1	1.5	0	1.5	0	6.5	-4	0.5
48	Kansas	1	0	1.5	1	2	0	5.5	-2	0.5
49	Mississippi	0.5	0	0	1	2.5	0	4	1	2
50	Wyoming	2	0	0	0	1.5	0	3.5	-2	0
51	North Dakota	0	1	0	1	0.5	0	2.5	0	1

Notes: ↑ denotes "most improved" states.

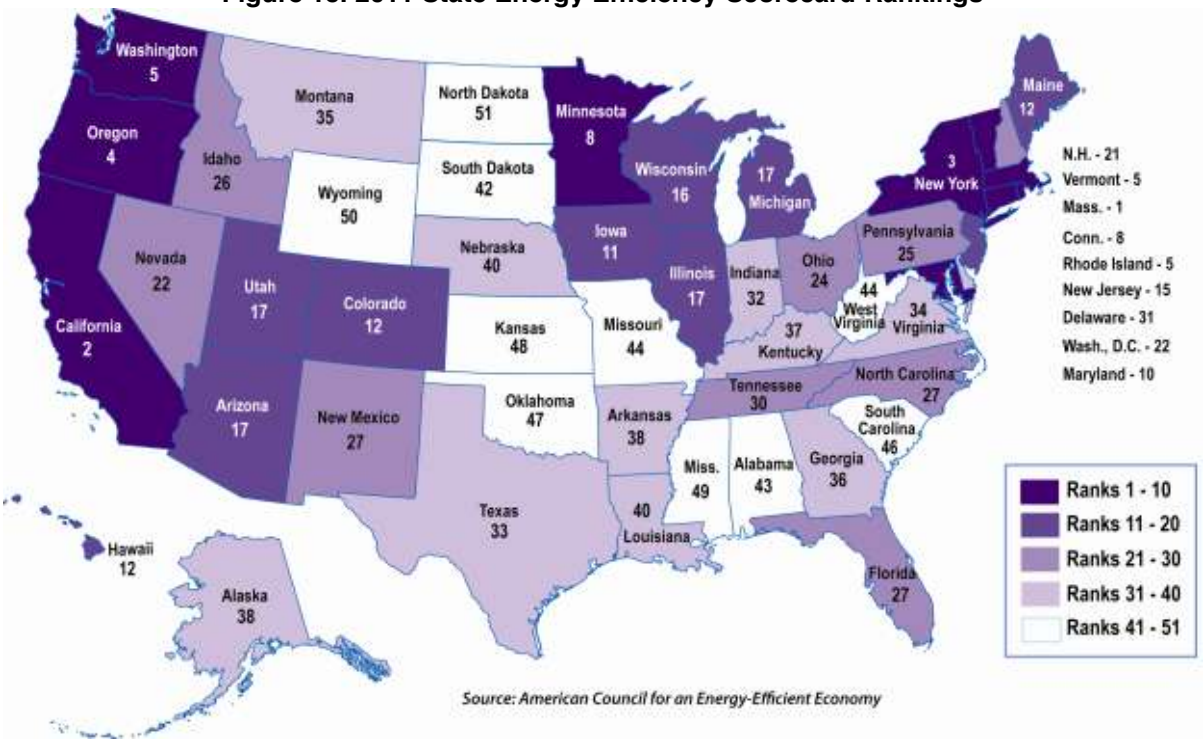
Differences among States

Although we provide individual state scores and rankings, we note that the difference between rankings is most significant in “bins” of ten or fifteen, rather than differences between individual rankings. The tiers of ten, as presented in Table 30, are therefore the best way to interpret the results of the *Scorecard.*

Changes in Scoring Methodology

Some minor changes in scoring methodology compared to last year may affect some of the overall rankings. The Utility and Public Benefits Fund Program and Policies chapter revised the methodology for scoring performance incentives and alternative regulatory business models for utilities to better capture the wide range of strategies undertaken by states. We reduced the appliance standards metric from three to two points and increased the transportation score from eight to nine points. In the Transportation section, we placed greater emphasis on policies that integrate land use and transportation planning. The Building Codes chapter readjusted the scoring methodology to reward full credit to states exceeding the 2009 IECC and ASHRAE 90.1-2007 codes or equivalent standards. In the State Government Initiatives chapter, we have included a new metric measuring state government policies and programs enabling the use of energy savings performance contracts (ESPCs), which allow states to enter into a performance-based agreement with an Energy Service Company (ESCOs). We also slightly changed the scoring methodology in the Building Codes chapter to award credit for states without statewide mandatory building energy codes for various levels of adoptions by major jurisdictions.

Figure 15. 2011 State Energy Efficiency Scorecard Rankings



Notes: Several states have the same score and tie for the same ranking, including 5, 8, 12, 17, 22, 27, 38, and 44. We do not score the U.S. territories due to lack of data, though hope to include them in future rankings.

"Most Improved" States

This year's most improved states compared to last year's *Scorecard* include Michigan, Maryland, Illinois, and Nebraska. Michigan, Illinois, and Maryland are reaping the rewards from Energy Efficiency Resource Standards (EERS) passed in 2008, which requires the states' utilities and state governments to provide portfolios of energy efficiency programs sufficient to meet a specific, energy savings target that ramps up over time. Each state increased ratepayer spending on utility sector energy efficiency programs from negligible levels in 2008 to substantial levels in 2010. Energy savings reflect the increased funding levels in these states, increasing from savings equivalent to around 0% of retail sales to 0.4% in 2009.

Aside from utility-sector energy efficiency, each of these states has made significant strides in other energy efficiency areas. Both Illinois and Maryland recently began offering financial incentives for high-efficiency vehicles. Michigan has undertaken significant efforts to retool its manufacturing industry to pursue clean energy technology development. A major piece of this effort is the research, development, and demonstration of energy efficiency technologies. Nebraska passed into law major upgrades to residential and commercial building codes in 2011, adopting a set of codes that will make homes and businesses comfortable and energy-efficient. The state also continues to be a leader in the implementation of state-government administered financing programs with the Dollar and Energy Savings Loan Program, which provides a wide range of customer classes with low-interest loans to make energy efficiency upgrades.

States Losing Ground

A number of states fell in the rankings, but in most cases, the fall can be attributed to other states making progress at faster pace rather than a state backsliding energy efficiency efforts. While twenty-five states fell in the rankings, only seven saw a decline in their total score. Pennsylvania, the state that fell farthest, fell ten places but only saw its score decrease by 3 points. In Pennsylvania's case, the state is in the process of implementing an EERS that will result in higher savings and investment levels, which future editions of the *Scorecard* will pick up. Movement among the states should be expected. The second and third tiers of the *Scorecard* are quite competitive as only four points separates 10th and 20th and 20th and 30th places. Idling states will not fare well as others ramp up efforts to become more energy-efficient.

Looking Ahead to 2012

In addition to the many states that have moved up in the rankings compared to last year's report, we see signs that states continue to raise the bar on energy efficiency program and policy commitments. Next year, we will see further improvements in leading states ramping up to meet aggressive energy savings targets such as New York and Massachusetts. Numerous states that only recently began implementing utility-sector energy efficiency programs such as Pennsylvania, Michigan, Ohio, Indiana, Arkansas, and Arizona will continue to ramp up efficiency program activity over the next few years to meet those rising goals.[67] A handful of states near the bottom of the Scorecard, including Georgia and Oklahoma, have also expanded energy efficiency program portfolios in recent years, which should be reflected in next year's *Scorecard*.

New and forthcoming rules from the EPA regulating emissions from multiple sources will dramatically alter the way emissions from some CHP systems are calculated and regulated. State regulatory approaches and programs currently in place that affect the way in which CHP system emissions are regulated may be rendered moot by future EPA activity. Such changes will be reflected in the 2012 Scorecard.

States will also face challenges that threaten to diminish the impact of energy efficiency in 2012. Uncertainty surrounding the economic recovery may dampen willingness among residential and commercial customers to invest in energy efficiency upgrades. If demand falters, energy efficiency programs may perform below expectations for customer participation rates, savings, and spending levels. Slowdowns in efficiency programs could lead to negative consequences in the regulatory and policy realm. State regulators may allow utilities to miss energy savings targets or impose cost caps or exit ramps that inhibit cost-effective program implementation. The strains on state budgets may compel state policymakers to raid ratepayer or RGGI funds to shore up state finances as has occurred in the past.

Further Areas of Research

The scoring framework we described at the beginning of this report is our best attempt to represent the myriad efficiency metrics as a quantitative "score." Any effort to convert state spending data, energy savings data, and adoption of best practice policies, across six policy areas, into one state energy efficiency "score" has its obvious limitations. We suggest here a few areas of future research that will assist our continuing efforts to refine the scoring methodology.

One of the most glaring limitations is access to reliable and recent data on results from energy efficiency efforts. Many states do not gather the data on performance of energy efficiency policy efforts, forcing us to score them using a "best practices" for some of the policy areas. For example, scoring states on building energy code compliance was difficult because states do not have the resources to collect the required data to estimate a state's level of compliance. While states should

[67] See (Nowak et al 2011) for a full discussion of how states are preparing to meet higher energy savings targets.

be applauded for adopting stringent building energy codes, the success of these codes at reducing energy consumption is indeterminable if we are unable to verify that they are actually being implemented. Inclusion of building energy code compliance metrics, based on a state-by-state review of compliance and enforcement activity, is an improvement over previous versions of the *Scorecard*, and we hope to continue to refine a survey of state code compliance in the future.

Next year, we hope to develop a more comprehensive and quantitative assessment of state efficiency programs that fall outside the realm of utility-sector and public benefits programs. Since the passage of the Recovery Act, scoring states on energy efficiency programs run by state governments has become a complex task. Our hope is that as ARRA funds run their course, states will be more adept at tracking and presenting program spending and savings data. We also hope to recognize state government and regulatory efforts to enable home- and business-owners to finance energy-efficiency improvements through on-bill financing, which allows utility customers to pay down improvements through their utility bills. The *Scorecard* does not address energy efficiency finance strategies such as Property Assessed Clean Energy (PACE), which allows property owners to use real tax liens to access commercial debt markets.

In the utility sector, we urge states to systematically track statewide savings and spending levels for energy efficiency programs. The current resources available for state-by-state comparisons of energy efficiency program spending and savings in the utility sector do not capture the full set of programs available to customers. In particular, programs administered by third-parties, public-power generators, and co-operative and municipal utilities are seriously undercounted in the major datasets used in this report. While we can fill some data gaps by conducting interviews with commission staff, future iterations of the *Scorecard* would benefit greatly from higher levels of reporting from utilities and administrators to the EIA, CEE, state utility commissions, and national groups such as the National Rural Electric Cooperative Association.[68] Furthermore, we would also like to capture spending and savings data for energy efficiency programs targeting home heating fuel and propane. In future editions of the *Scorecard*, we plan to examine metrics for fuel oil and propane efficiency, as well as energy savings from natural gas.

Additionally, we will look further into the potential for giving states credit for incentive programs for solar hot water systems, which are a proven energy-saving technology. Finally, as U.S. territories ramp up energy efficiency efforts, we hope that the data becomes robust enough for integration in the *Scorecard*. The current sets of data do not allow for proper comparisons and the activity is fairly minimal beyond ARRA-related programs. We will continue looking into the possibility in future editions of the *Scorecard*.

CONCLUSIONS

Energy efficiency policies and programs continued to advance at the state level in 2011. A group of leading states remains steadfast in their commitment to the efficient use of energy in transportation, buildings, and industry, fostering economic development in the energy efficiency services and technology industry and saving money for consumers to spur growth in all sectors of the economy. A growing number of states have progressed, some rapidly, over the past few years in the pursuit of reaching their full energy efficiency potential. A wide gap remains, however, between states near the top and those at the bottom of the *Scorecard* rankings. Because of market barriers and the regulated nature of the energy sector, a regulatory environment that encourages energy efficiency is critical to reach its full potential. The findings presented in the Scorecard should guide states efforts to harness the power of energy efficiency in all economic sectors. Energy efficiency is a resource abundant in every state and reaching its full potential will be critical to meeting the environmental, economic, and reliability demands of the next century.

[68] A forthcoming report from M.J. Bradley & Associates delves deeper into the data gaps that inhibit the comprehensive benchmarking of utility energy efficiency spending and savings.

REFERENCES

[AASHTO] American Association of State Highway Transportation Officials. 2010. *Survey of State Funding for Public Transportation.* Washington, D.C.: American Association of State Highway Transportation Officials.

[AEG] Applied Energy Group. 2011. Personal communication with Craig Moran. August 15th.

[AEG] Applied Energy Group. 2011b. Personal communication with Mike Ambrosio. September 7th.

[AGA] American Gas Association. 2010. Fact Sheet "*Decoupling and Natural Gas Utilities."* August. American Gas Association.

[ARB] Air Resources Board, California Environmental Protection Agency. 2010a. Draft Regional Greenhouse Gas Emission Reduction Targets for Automobiles and Light Trucks Pursuant to Senate Bill 375. Sacramento, CA. Air Resources Board, California Environmental Protection Agency.

———. 2010b. "Hybrid Truck and Bus Voucher Incentive Project." http://www.californiahvip.org/. Accessed July 2010. Sacramento, CA. Air Resources Board, California Environmental Protection Agency.

[AVISTA] Avista Utilities. 2010. *Avista Utilities Energy Efficiency Annual Report: 2009 Performance Report.* http://www.puc.idaho.gov. Idaho Public Utilities Commission.

[AZCC] Arizona Corporation Commission. 2011. Personal Communication with Laura Furrey. July 17th.

Barbose, G., C. Goldman, and J. Schlegel. 2009. *The Shifting Landscape of Ratepayer-Funded Energy Efficiency in the U.S.* Berkeley, Calif.: Lawrence Berkeley National Laboratory.

[BCAP] Building Codes Assistance Project. 2010. *Code Status and Maps.* http://www.bcap-energy.org/. Accessed September 2010.

Bernstein, Mark; Fonkych, Kateryna; Loeb, Sam; and Loughran, David. 2003.*State-Level Changes in Energy Intensity and Their National Implications.* Science and Technology Policy Institute, Prepared for the U.S. Department of Energy by RAND.

[CEE] Consortium for Energy Efficiency. 2010. *State of the Efficiency Program Industry: 2009 Expenditures, Impacts, and 2010 Budgets.* http://www.cee1.org/ee-pe/2010AIR.php3 posted December 2010.

[Census] United States Census Bureau. 2011. *Table 1. Preliminary Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010 (NST-PEST2010-01).* Washington, D.C.: United States Census Bureau.

Clean Cars Campaign. 2011. State Action. http://www.cleancarscampaign.com/. Accessed June 2011.

[CPUC] California Public Utilities Commission. 2011. *Energy Efficiency Evaluation Report for the 2009 Bridge Funding Period.* California Public Utilities Commission.

[CT ECMB] Connecticut Energy Conservation Management Board. 2010. *Report of the Energy Conservation Management Board Year 2009 Programs and Operations.* New Britain, Conn.:

Energy Conservation Management Board. http://www.ctsavesenergy.org/files/Final%202009%20Legislative%20Report%202.19.10.pdf

[CO PSCo] Public Service Company of Colorado. 2010. *2009 Demand-Side Management Annual Status Report*. Docket 08A-366 EG.

[DDOE] District of Columbia Department of the Environment. 2011. Personal communication with Taresa Lawrence. July 27th.

[DNREC] Delaware Department of Natural Resources and Environmental Control. 2011. Personal communication with Cara Lampton. September 22nd.

[DOE] U.S. Department of Energy. 2008. *2008 Buildings Energy Data Book.* http://buildingsdatabook.eere.energy.gov/. Washington, D.C.: U.S. Department of Energy, Energy Efficiency and Renewable Energy.

[DOE] U.S. Department of Energy. 2011a. "Alternative Fuel and Advanced Vehicle Data Center: Hybrid Electric Vehicle Incentives and Laws." http://www.afdc.energy.gov/afdc/vehicles/hybrid_electric_laws.html. Accessed July 2011. Washington D.C.: U.S. Department of Energy, Energy Efficiency and Renewable Energy.

_____. 2011b. Status of State Energy Codes. http://www.energycodes.gov/implement/state_codes/index.stm. Accessed September 2011. Washington, D.C.: U.S. Department of Energy, Energy Efficiency and Renewable Energy.

Doris, E., J. McLaren, V. Healy, and S. Hockett. 2009. *State of the States 2009: Renewable Energy Development and the Role of Policy*. Golden, Co.: National Renewable Energy Laboratory.

[DSIRE] Database of State Incentives for Renewable Energy. 2011. www.dsireusa.org. Accessed June - September 2011.

[EIA] Energy Information Administration. 2011a. *Form EIA-861 Final Data File for 2009.* http://www.eia.gov/cneaf/electricity/page/eia861.html. Washington, D.C. U.S. Department of Energy, Energy Information Administration.

_____. 2011b. *Electric Power Annual.* http://www.eia.gov/cneaf/electricity/epa/epa_sum.html Washington, D.C.: U.S. Department of Energy, Energy Information Administration.

_____. 2011c. *Annual Energy Outlook*. http://www.eia.gov/forecasts/aeo/. Washington, D.C.: U.S. Department of Energy, Energy Information Administration.

_____. 2011d. *Electric Power Monthly*. http://www.eia.gov/cneaf/electricity/epm/epm_sum.html. Washington, D.C.: U.S. Department of Energy, Energy Information Administration.

Ehrhardt-Martinez, K. and Laitner, J.S. 2008. *The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie, Michael Sciortino, Laura Furrey, Seth Nowak, Shruti Vaidyanathan, Max Neubauer, Nate Kaufman, Anna Chittum, and Sarah Black. 2009. *The 2009 State Energy Efficiency Scorecard.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie, M. Neubauer, D. York, S. Vaidyanathan, A. Chittum, and S. Nadel. 2008. *The 2008 State Energy Efficiency Scorecard.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie, Bill Prindle, Dan York, and Steve Nadel. 2007. *The State Energy Efficiency Scorecard for 2006*. Washington, D.C.: American Council for an Energy-Efficient Economy.

[EM] Efficiency Maine 2010. *Efficiency Maine 2010 Annual Report*. http://www.efficiencymaine.com/documents-services/reports. State of Maine.

[EPA] Environmental Protection Agency. 2009. *Lead by Example Guide.* http://www.epa.gov/statelocalclimate/documents/pdf/epa_lbe_full.pdf Washington, D.C.: U.S. Environmental Protection Agency.

_____. 2011. "United States Environmental Protection Agency Combined Heat and Power Partnership Funding Database." http://www.epa.gov/chp/funding/funding.html. Washington, D.C.: U.S. Environmental Protection Agency.

[ETO] Energy Trust of Oregon. 2011. Personal Communication with Adam Shick. September 22nd.

[FOE] Tetra Tech. 2011. *Focus on Energy Evaluation Annual Report (2010).* Public Service Commission of Wisconsin. http://www.focusonenergy.com/files/Document_Management_System/Evaluation/annualreport2010_evaluationreport.pdf

Freehling, Joel. 2011. *Energy Efficiency Finance 101: Understanding the Marketplace.* ACEEE White Paper. Washington D.C.: American Council for an Energy-Efficient Economy.

Friedrich, K., Amman, J., Vaidyanathan, S., and Elliott, R.N.. 2010. *Visible and Concrete Savings: Case Studies of Effective Behavioral Approaches to Improving Customer Energy Efficiency.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Frontier Associates. 2011. Personal Communication with Amy Martin. July 22nd.

[FTA] U.S. Department of Transportation, Federal Transit Administration. 2010. "The American Recovery and Reinvestment Act." http://www.fta.dot.gov/index_9440.html Accessed July 2010. Washington D.C.: U.S. Department of Transportation, Federal Transit Administration.

Goldman, Charles A., E. Stuart, I. Hoffman, M. Fuller, and M.A. Billingsley. 2011. *Interactions between Energy Efficiency Programs funded under the Recovery Act and Utility Customer-Funded Energy Efficiency Programs*. Berkeley, CA: Lawrence Berkeley National Laboratory.

Hawaii Energy. 2010. *Hawaii Energy PY2009 Annual Report Executive Summary*. Hawaii Energy.

Hendricks, Bracken, B. Campbell, and P. Goodale. 2010. *Efficiency Works: Creating Good Jobs and New Markets through Energy Efficiency*. Washington, D.C.: Center for American Progress and Energy Resource Management Corp.

Horowitz, Marvin J. 2011. "Measuring the Savings from Energy Efficiency Policies: A Step Beyond Program Evaluation." Energy Efficiency, Vol.4, No.1, pp. 43-66.

[ICF] ICF International, Inc. 2009. *Energy & Cost Savings Analysis of 2009 IECC Efficiency Improvements*. Prepared for the Energy Efficient Codes Coalition (EECC). Fairfax, VA: ICF International.

[IEE] Institute for Electric Efficiency. 2010. *State Electric Efficiency Regulatory Frameworks.* Washington, D.C.: Institute for Electric Efficiency.

[IDP] Idaho Power. 2010. *Demand-Side Management 2009 Annual Report* http://www.puc.idaho.gov. Idaho Public Utilities Commission. CASE NO. IPC-E-10-09

[ID PUC] Idaho Public Utilities Commission. 2011. Personal communication with Lynn Anderson. August 18th.

[ID RMP] Rocky Mountain Power. 2010. *Rocky Mountain Power Demand Side Management Annual Report* – Idaho. http://www.puc.idaho.gov. Idaho Public Utilities Commission Case No. PAC-E-05-10

[IL DCEO] Illinois Department of Commerce and Economic Opportunity. 2011. Personal communication with David Baker. August 10th.

[IMT] Institute for Market Transformation. 2011. *Building Energy Performance Benchmarking and Disclosure.* http://www.imt.org/rating.html. Accessed July – September 2011.

[KCC] Kansas Corporation Commission. 2011. Personal communication with Michael Deupree. August 1st.

Kerth, Rob and Sargent, Rob. 2011. *A Program that Works: How the Regional Greenhouse Gas Initiative Is Helping the Northeast Shift to Clean Energy and Reduce Pollution from Fossil Fuels.* Environment America Research & Policy Center.

Kushler, M., D. York and P. Witte. 2006. Aligning Utility Interests with Energy Efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Incentives. Washington, D.C.: American Council for an Energy-Efficient Economy.

[KY PSC] Kentucky Public Service Commission. 2011. Personal communication with Jeff Shaw. August 1st, 2011.

Laitner, John A, "Skip," R. Gold, S. Nadel, T. Langer, R.N. Elliott, and D. Trombley. 2010. *The American Power Act and Enhanced Energy Efficiency Provisions: Impacts on the U.S. Economy*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Loughran, D. S., & Kulick, J. (2004). Demand side management and energy efficiency in the United States. The Energy Journal, 25(1), 19–43.

[MA DOER] Massachusetts Department of Energy Resources. 2011. Personal communication with Lawrence Masland. August 2nd.

[MD PSC] Maryland Public Service Commission. 2011. Personal communication with Matthew Mansfield. September 20.

McKinsey & Company. 2009. *Unlocking Energy Efficiency in the U.S. Economy.* http://www.mckinsey.com/en/Client_Service/Electric_Power_and_Natural_Gas/Latest_thinking/~/media/McKinsey/dotcom/client_service/EPNG/PDFs/Unlocking%20energy%20efficiency/US_energy_efficiency_full_report.ashx. McKinsey and Company.

Merkley, Jeff. 2010. *America Over a Barrel: Solving Our Oil Vulnerability*. Washington D.C.: Senator Jeff Merkley.

[MI PSC] Michigan Public Service Commission. 2010. *Report on the Implementation of P.A. 295 Utility Energy Optimization Programs.*

[MN PUC] Minnesota Public Utilities Commission. 2011. Personal communication with Joe Plummer. July 27th.

Molina, M., Elliott, R.N., Vaidyanathan. 2010. *North Carolina's Energy Future: Electricity, Water, and Transportation Efficiency*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Molina, M., Watson, S., Kaufman, N., Laitner, J.S., Mackres, E., Trombley, D., and York, D. 2011. *Missouri's Energy Efficiency Potential: Opportunities for Economic Growth and Energy Sustainability.* Washington, D.C.: American Council for an Energy-Efficient Economy.

[MO PSC] Missouri Public Service Commission. 2011 Personal communication with Michelle Bocklage. July 28th.

[MT PSC] Montana Public Service Commission. 2011. Personal communication with Will Rosquist. July 27th.

Muro, M., J. Rothwell, and D. Saha. 2011. *Sizing the Clean Economy: A National and Regional Jobs Assessment*. Washington, D.C.: The Brookings Institution.

Nadel, S., T. Kubo, and H. Geller. 2000. *State Scorecard on Utility Energy Efficiency Programs in 2000.* Washington, D.C.: American Council for an Energy-Efficient Economy.

[NASEO] National Association of State Energy Officials. 2011. *NASEO Resources*. http://www.nga.org/cms/home/nga-center-for-best-practices/center-publications/page-eet-publications/col2-content/main-content-list/clean-and-secure-state-energy-ac.html. Accessed July-September 2011.

[NCFSA] National Conference of State Fleet Administrators. 2007. 2007 *NCSFA Target Membership Estimated Fleet Totals and Dollars (Reported by State Fleets).* http://www.ncsfa.net/PUBLICATIONS/Conference/2007%20NCSFA%20Est.%20Target%20Fleet$.pdf. Gaithersburg, Md.: National Conference of State Fleet Administrators.

[NCSC] National Complete Streets Coalition. 2010. *Complete Streets Policy Analysis 2010: A Story of Growing Strengths*. Washington D.C.: National Complete Streets Coalition.

Neubauer, M., A. deLaski, M. Dimascio, and S. Nadel. 2009. *Ka-Boom! Appliance Standards Make a Big Bang.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Neubauer, M., Watson, S. Laitner, J.S., Talbot, J., Trombley, D., Chittum, A., Black, S. 2009b. *South Carolina's Energy Future: Minding its Efficiency Resources*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Neubauer, M., Nadel, S., Talbot, J., Lowenberger, A., Trombley, D., Black, S., Vaidyanathan, S., Foster, B., Laitner, J.S. 2011. *Advancing Energy Efficiency Opportunities in Arkansas: Opportunities for a Clean Energy Economy*. Washington, D.C.: American Council for an Energy-Efficient Economy.

[NGA] National Governor's Association. 2010. *Clean Energy State Actions: 2010 Update.* http://www.nga.org/cms/home/nga-center-for-best-practices/center-publications/page-eet-publications/col2-content/main-content-list/clean-and-secure-state-energy-ac.html. Accessed July-September 2011.

[NH PUC] New Hampshire Public Utility Commission. 2011. Personal Communication with Jim Cunningham. August 27th.

NJ Spotlight. 2011. "Your clean energy funds at work" June 14th, 2011. http://www.njspotlight.com/stories/11/0614/0005/

[NJ-Online] NJ-Online LLC. 2011. "Gov. Christie announces N.J. pulls out of regional environmental initiative." May 26th. http://www.nj.com/politics/index.ssf/2011/05/gov_christie_to_announce_nj_pu.html

[NM PRC] New Mexico Public Regulatory Commission. 2011. Personal Communication with James Brack. July 20th.

Nowak, Seth, Martin Kushler, Michael Sciortino, Dan York, and Patti Witte. 2011. *Energy Efficiency Resource Standards: State and Utility Strategies for Higher Energy Savings.* Washington, D.C.: American Council for an Energy-Efficient Economy.

[NRDC] Natural Resources Defense Council. 2011. *Ranking States' Oil Vulnerability and Solutions for Change.* Washington D.C.: Natural Resources Defense Council.

[NYSERDA] New York Energy Research and Development Authority. 2011a. Personal communication with Victoria Engel-Fowles. August 4th.

[NYSERDA] New York Energy Research and Development Authority. 2011b. Personal communication with Victoria Engel-Fowles. August 25th.

[PA PUC] 2010. *Act 129 Statewide Evaluator Report: Program Year 1: June 1, 2009 – May 31, 2010.* Prepared by the Statewide Evaluation Team: GDS Associates, Inc., Nexant, Mondre Energy, and Syntil, Inc.

[PNNL] Pacific Northwest National Laboratory. 2009. *Comparison of Standard 90.1-07 and the 2009 IECC with Respect to Commercial Buildings*. Richland, WA: Pacific Northwest National Laboratory.

[RGGI] Regional Greenhouse Gas Initiative, Inc. 2011. *Investment of Proceeds from RGGI CO2 Allowances.* New York, NY: RGGI Inc.

[RI PUC] Rhode Island Public Utilities Commission. 2010a. *Energy Efficiency Program Plan for 2011: Settlement of the Parties.* Docket No. 4209. November 1.

____. 2010b. *Responses to Commission's First Set of Data Requests.* Docket 4209. Issued November 22. http://www.ripuc.org/eventsactions/docket/4209-NGrid-DR-PUC1(12-7-10).pdf

____. 2010c. *Revised Attachment 6.* Docket 4209. December 6. http://www.ripuc.org/eventsactions/docket/4209-NGrid-RevAttach6(12-6-10).pdf

[RMP] Rocky Mountain Power. 2010. *2010 Annual Energy Efficiency and Peak Reduction Report – Utah.* http://www.psc.state.ut.us/utilities/electric/elecindx/2011/1103574indx.html

Salt River Project. 2010. *FY2010 Energy Efficiency Portfolio Evaluation Summary.* Prepared by The SRP Measurement and Evaluation Department and The Cadmus Group. http://www.srpnet.com/environment/earthwise/pdfx/spp/FY10EE_Portf_Eval_Sum_Aug2010.pdf.

Satchwell, Andrew, C. Goldman, P. Larsen, D. Gilligan, and T. Singer. 2010. *A Survey of the U.S. ESCO Industry: Market Growth and Development from 2008 to 2011.* Berkeley, CA: Lawrence Berkeley National Laboratory.

Sciortino, Michael. 2010. *States Stepping Forward: Best Practices for State-Led Energy Efficiency Programs.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Sciortino, Michael and Eldridge, Maggie. 2010. *The Growing Landscape of State Energy Efficiency Programs: A New Taxonomy*. ACEEE Summer Study in Buildings Proceedings. Washington, D.C.: American Council for an Energy-Efficient Economy.

Sciortino, Michael, S. Nowak, P. Witte, D. York, and M. Kushler. 2011. *Energy Efficiency Resource Standards: A Progress Report on State Experience*. Washington D.C.: American Council for an Energy-Efficient Economy.

Sciortino, Michael. 2011. *How States Enable Local Governments to Advance Energy Efficiency*. ACEEE White Paper. Washington D.C.: American Council for an Energy-Efficient Economy.

[SD PUC] South Dakota Public Utilities Commission. 2011. Personal communication with Brian Rounds. July 29th.

Sheppard, Colin; Chamberlin, Charles; and Jacobson, Arne. 2009. *Exploring Strategies for Implementing a Performance based State Efficiency Program: State Energy Consumption Metrics – Residential Sector Analyses.* Schatz Energy Research Center, Humboldt State University, prepared for Natural Resources Defense Council, Center for Market Innovation, Project Managers Yerina Mugica and Rick Duke.

[SWEEP] Southwest Energy Efficiency Project. 2007. Geller, H., S. Baldwin, P. Case, K. Emerson, T. Langer & S. Wright. *Utah Energy Efficiency Strategy: Policy Options*. Boulder, CO: Southwest Energy Efficiency Project.

____. 2009. Personal communication with Jim Meyers. October 8.

____. 2010. Personal communication with Howard Geller. July 30.

[TVA] Tennessee Valley Authority. 2010. Personal communication with Edward L. Colston, August 10th.

[VT PSB] Vermont Public Service Board. 2011. Personal communication with June Tierney. August 1st.

[WA UTC] Washington Utilities and Transportation Commission. 2011. Personal communication with Deb Reynolds. August 3rd.

Xcel Energy. 2011. Personal communication with Suzanne Doyle. July 21st.

York, D. and M. Kushler. 2002. *State Scorecard on Utility and Public Benefits Energy Efficiency Programs: An Update*. Washington, D.C.: American Council for an Energy-Efficient Economy.

_____. 2005. *ACEEE's 3rd National Scorecard on Utility and Public Benefits Energy Efficiency Programs: A National Review and Update of State-Level Activity*. Washington, D.C.: American Council for an Energy-Efficient Economy.

APPENDIX A. UTILITY AND PUBLIC BENEFITS FUND ENERGY EFFICIENCY BUDGETS PER CAPITA

2010 State Electricity Efficiency Program Budgets per Capita

State	2010 Budgets ($1,000)	Spending per Capita
Vermont	$34.0	$54.62
Massachusetts	$301.9	$45.53
Connecticut	$126.9	$35.97
California	$1,158.1	$31.08
Minnesota	$160.2	$30.28
Rhode Island	$32.1	$30.40
New York	$583.6	$29.81
Washington	$184.9	$27.42
Oregon	$91.1	$23.63
Idaho	$36.1	$23.14
New Jersey	$198.1	$22.68
Iowa	$67.8	$22.43
New Hampshire	$26.3	$19.87
Utah	$55.5	$19.61
Nevada	$45.0	$16.95
Wisconsin	$92.3	$16.28
Maryland	$88.8	$15.48
District of Columbia	$9.4	$15.36
Hawaii	$19.3	$14.85
Arizona	$92.3	$13.82
Ohio	$152.8	$13.25
Maine	$14.0	$12.97
Illinois	$165.5	$12.79
Colorado	$64.7	$12.70
Michigan	$91.5	$9.21
Montana	$8.9	$9.06
Pennsylvania	$110.0	$8.71
New Mexico	$17.5	$8.60
Wyoming	$4.3	$7.85
Tennessee	$48.9	$7.71
Oklahoma	$27.9	$7.49
Nebraska	$13.0	$7.18
Missouri	$40.5	$6.74
Florida	$123.2	$6.60
Kentucky	$27.1	$6.25
Texas	$128.4	$5.09
North Carolina	$45.3	$4.79
Arkansas	$13.1	$4.50
South Dakota	$3.5	$4.22
Mississippi	$12.5	$4.22
Delaware	$3.6	$4.02
Alabama	$17.7	$3.74

State	2010 Budgets ($1,000)	Spending per Capita
South Carolina	$12.3	$2.68
Indiana	$16.5	$2.56
Georgia	$21.6	$2.18
North Dakota	$1.3	$2.02
Kansas	$5.4	$1.90
Alaska	$0.4	$0.55
Virginia	$0.2	$0.03
Louisiana	$0.0	$0.00
West Virginia	$0.0	$0.00
U.S. Total	**$4,595.7**	**$14.87**

*Utility spending is on "ratepayer-funded energy efficiency" programs, or energy efficiency programs funded through charges included in customer utility rates or otherwise paid via some type of charge on customer bills. This includes both utility-administered programs and "public benefits" programs administered by other entities. We do not include data on load management programs or energy efficiency research and development. Population data gathered from (Census 2011).

APPENDIX B: EXPANDED TABLE OF STATE RD&D PROGRAMS

State	Major RD&D Programs	Score
Alaska	The **Cold Climate Housing Research Center** in Fairbanks, Alaska conducts applied research, development, and deployment on sustainable, energy-efficient and healthy buildings in Alaska and the circumpolar north. The Alaska Housing Finance Corporation (AHFC) has a **Research Information Center** (RIC) and the Alaska Energy Authority oversees the **Emerging Energy Technology Fund**, which concentrates heavily on energy efficiency technologies.	2
California	**The California Energy Commission's Public Interest Energy Research (PIER)** program supports research and development in several key areas including energy efficiency for buildings, industry, agriculture, and water systems; generation for renewable resources, combined heat and power, and advanced generation; transportation and alternative fuels, vehicle efficiency, and biofuels; technology systems and smart grid, transmission, and distribution; and environmental research on minimizing impacts from renewable energy development, climate change adaptation and mitigation, and improving indoor air quality. PIER is funded from a surcharge on electricity and natural gas use in the state and totals about $80 million per year.	2
Iowa	The **Iowa Energy Center** advances energy efficiency through research, education, and demonstration. Amongst its many goals, the Iowa Energy Center strives to advance efficiency and renewable energy within the state through research and development while providing a model for the state to decrease its dependence on imported fuels.	2
Massachusetts	**Massachusetts Energy Efficiency Partnership (MAEEP)** supports demonstration of energy efficiency technology and tools to the industrial, commercial, and institutional sectors. The MAEEP program leverages resources from USDOE, the University of Massachusetts and Massachusetts Electric Utilities, NSTAR, MECO and WMECO, in partnership. Massachusetts is also offering **High Performance Green Building Grants** to demonstrate innovative ways to improve energy performance in various types of buildings. The grants will use $16.25 million of ARRA funds to leverage an additional $42.5 million from grant recipients. The state's program administrators also have a number of deep energy retrofits and behavioral pilot programs.	2
Michigan	The **Michigan NextEnergy Center** includes laboratory facilities, business incubator space, and other facilities to support the state's alternative energy industry. Energy efficiency and battery storage are central to the NextEnergy Center. As a Renaissance Zone, businesses within the NextEnergy Center may be eligible for tax benefits aside from the numerous tax credits the state offers alternative energy businesses.	2
New York	**The New York State Energy Research and Development Authority (NYSERDA)** RD&D efforts include a wide range of energy efficiency and renewables programs, including, but not limited to, a Renewable Portfolio Standard (RPS), a Regional Greenhouse Gas Initiative (RGGI), clean energy business development, the Smart Grid Consortium and the Battery Energy Storage (BEST) Consortium. NYSERDA's 2009/10 RD&D budget was approximately $165 million.	2
North Carolina	The **North Carolina Green Business Fund** provides grants of up to $100,000 to North Carolina small and mid-size businesses, nonprofit organizations, state agencies, and local governments to encourage the development and commercialization of promising renewable energy and energy-efficient building technologies. The **NC Solar Center** also focuses on energy efficiency to assist commercial and industrial clients in saving energy. This team has grown over the years and now operates multiple programs focusing on Combined Heat & Power (CHP) technology in the Southeast.	2
Ohio	Funded through a 2007 job stimulus package, **Ohio Air Quality Development Authority (AQDA) Advanced Energy Program Grants** will provide $84 million to non-coal related projects. CHP is deemed eligible. **Energy Industries of Ohio** (EIO), a nonprofit corporation that obtains funding from numerous sources to support R&D programs, also seeks to develop, demonstrate, and incubate technologies that will improve the competitiveness of Ohio industry through	2

State	Major RD&D Programs	Score
	increased energy efficiency. The **Ohio Third Frontier Program** also supports energy efficiency in areas such as electric automobile research.	
Oregon	The **Oregon State University Energy Efficiency Center** houses the OSU Industrial Assessment Center, offers rural energy audits, OSU facility assessments, and other customized assessments. The Center focuses on energy efficiency training, and performs related research, analysis, and data collection. The **University of Oregon Energy Studies in Building Laboratory** conducts research on buildings and related transportation to develop strategies for maximum energy efficiency in new materials, components, assemblies, and whole buildings. It has received funding from numerous private and public sources. The **Oregon Built Environment and Sustainable Technologies Center (BEST)** shares research facilities for study of energy-efficient and green buildings. **Portland State University's Renewable Energy Research Lab** conducts sustainable urban development research, which covers smart grid development and net-zero energy use. **The Baker Lighting Lab at University of Oregon** studies daylighting and control of these systems. The **Energy Trust of Oregon** also runs programs to field test emerging technologies.	2
West Virginia	West Virginia has established a number of initiatives to advance energy efficiency, particularly in its industrial and manufacturing sectors. The state has been active in analyzing energy usage in manufacturing facilities across the state, funding benchmarking initiatives for companies of all sizes. The **Energy Efficiency Center of West Virginia** and **West Virginia University Building Energy Center** partner with West Virginia Industries of the Future and the state Manufacturing Extension Partnership to provide centralized locations for the development of new energy-saving technologies and services.	2
Wisconsin	The **Energy Center of Wisconsin** conducts technology and field research; education programs; program evaluation and market research; program development, and implementation. The Energy Center, funded through state, ratepayer, private, and other sources, features an award-winning program on building energy use in commercial new construction. Other research focuses on buildings and market characteristics, as well as bio-energy. **Wisconsin Focus on Energy** operates an Emerging Technology (ET) program that promotes emerging, industrial, energy efficiency technologies. The program deploys and commercializes those emerging industrial technologies that have the potential for large, cost-effective energy savings and multiple installations in Wisconsin.	2
Colorado	**Clean Energy SuperClusters at Colorado State University** are multidisciplinary alliances integrating experts from diverse fields with the goal of rapidly developing products emerging from world class clean energy research. The SuperClusters commonly fund and support energy efficiency projects.	1
Florida	**Florida Solar Energy Center**'s building science program includes research projects concentrating on: Building America Industrialized Housing; Zero Energy Buildings; Fenestration; Energy Efficient Schools; Green Standards; and Ceiling Fans.	1
Minnesota	**The Conservation Applied Research & Development (CARD) Fund** receives $3.1M annually in ratepayer funding to identify new technologies or strategies to maximize energy savings, improve the effectiveness of energy conservation programs, or document carbon dioxide reductions from energy conservation programs.	1
New Jersey	The New Jersey Commission on Science and Technology (CST) administers the **Edison Innovation Clean Energy Fund** through a Memorandum of Understanding with the New Jersey Board of Public Utilities (BPU). The Clean Energy Fund provides grants of $100,000 to $500,000 to New Jersey companies for demonstration projects and developmental and ancillary activities necessary to commercialize identified renewable energy technologies and innovative technologies that significantly increase energy efficiency. All grants are subject to a 50% matching funds requirement. Businesses may also apply for and receive up to 20% of the approved grant amount in equity-like financing from the New Jersey Economic Development Authority (EDA) for non-research and development related costs.	1
New Mexico	The **Energy Innovation Fund** was created in 2007 to accelerate the development	1

State	Major RD&D Programs	Score
	of innovation and enable faster commercial adaptation of clean energy technologies in New Mexico. State appropriations of $2.7M and equal matching private sector investment provided funding for projects awarded in FY08 and FY09. The Energy, Minerals and Natural Resources Department manages the awarded projects.	
Tennessee	The **University of Tennessee** and Tennessee Valley Authority partner with **Oak Ridge National Laboratory** to conduct a number of energy efficiency initiatives. The state also funds the University of Tennessee Research Foundation, which focuses on advanced energy technologies.	1
Texas	The **Texas A&M Energy Systems Laboratory (ESL)** focuses on energy-related research, energy efficiency, and emissions reduction. Some specialized areas include: metering and modeling energy use in buildings; optimization of HVAC systems; and modeling and analysis. ESL plays an important role in the implementation of state energy standards.	1
Vermont	**Efficiency Vermont** is conducting a research study related to how smart grid technologies and consumer behavior can deliver cost-effective energy efficiency savings. As a "franchise" utility, Efficiency Vermont will now have the long-term certainty needed to invest more in RD&D in the years to come.	1
Virginia	Virginia is implementing a $40 million energy infrastructure research and development initiative, which funding the Modeling and Simulation Center for Collaborative Technology in Halifax County to undertake R&D work in energy-efficient advanced manufacturing .	1
Delaware	Delaware offers two RD&D grant programs run through the Green Energy Fund. **Research and Development Grants** offers up to 35% of the cost of qualifying projects, which include energy efficiency technologies. The grants have an annual budget of up to $288,000 annually. **Technology and Demonstration Grants** fund up to 25% of project cost and may be funded up to $720,000 annually.	0.5
Georgia	Funded in part by Georgia Environmental Finance Authority (GEFA), **Southface Energy Institute** conducts research and training on energy-efficient housing and communities. GEFA collaborates with Southface on its weatherization training and technical assistance.	0.5
Hawaii	The ***Transportation Energy Transformation Program*** focuses on deployment with the ***Hawaii EV Ready Program*** and the ***State Fleet Program***. The Hawaii EV Ready Program provides grants and rebates for the installation of electric vehicle chargers and the purchase of new, commercially-available full-speed electric motor vehicles. The program expects results of 1,000–5,000 electric vehicle chargers installed and 200–600 electric vehicle purchases supported by grant and rebate funds.	0.5
Illinois	The **University of Illinois at Chicago Energy Resources Center** focuses on energy conservation and production technologies. Its programs include: energy management assessments; economic modeling; analysis of policy and regulatory initiatives; and public outreach and education. ERC staff work across all market sectors on projects impacting the industrial, commercial, and residential markets.	0.5

APPENDIX C: STATE AND FEDERAL TRANSIT FUNDING

State	FY 2008State Funding	Population	Per Capita Transit Expenditure
Massachusetts	$1,182,785,342	6,544,089	$180.74
New York	$3,015,441,656	19,464,482	$154.92
Maryland	$844,417,234	5,650,870	$149.43
Alaska	$86,814,875	685,532	$126.64
New Jersey	$1,035,472,354	8,657,319	$119.61
Delaware	$86,232,800	876,794	$98.35
Pennsylvania	$1,145,567,000	12,562,536	$91.19
District of Columbia	$272,724,274	3,500,000	$77.92
Connecticut	$267,499,842	3,502,664	$76.37
Minnesota	$339,925,000	5,230,247	$64.99
California	$2,299,578,879	36,538,008	$62.94
Rhode Island	$47,338,005	1,058,368	$44.73
Illinois	$519,300,000	12,836,402	$40.46
Virginia	$228,965,893	7,780,691	$29.43
Wisconsin	$125,179,500	5,627,257	$22.25
Michigan	$200,086,889	9,999,456	$20.01
Oregon	$39,920,803	3,780,596	$10.56
Vermont	$5,899,044	620,967	$9.50
Indiana	$55,733,074	6,386,601	$8.73
North Carolina	$73,466,447	9,230,086	$7.96
Florida	$146,338,770	18,410,241	$7.95
Tennessee	$41,537,000	6,239,542	$6.66
Washington	$39,751,905	6,566,085	$6.05
Wyoming	$2,495,659	532,626	$4.69
New Mexico	$9,296,786	1,984,179	$4.69
Colorado	$23,048,479	4,928,676	$4.68
North Dakota	$2,900,000	640,525	$4.53
Iowa	$13,280,543	2,994,658	$4.43
New Hampshire	$4,474,250	1,320,981	$3.39
Kansas	$5,761,639	2,795,257	$2.06
Arizona	$11,780,000	6,499,207	$1.81
West Virginia	$3,023,342	1,816,352	$1.66
Nebraska	$2,900,000	1,780,143	$1.63
Oklahoma	$5,750,000	3,640,241	$1.58
Arkansas	$4,515,157	2,867,099	$1.57
South Carolina	$6,400,000	4,497,746	$1.42
Ohio	$15,816,982	11,526,691	$1.37
Louisiana	$5,962,530	4,448,806	$1.34
Texas	$28,741,067	24,290,611	$1.18
Missouri	$6,921,541	5,951,844	$1.16
Maine	$1,527,654	1,318,133	$1.16
South Dakota	$770,000	803,047	$0.96

State	FY 2008State Funding	Population	Per Capita Transit Expenditure
Kentucky	$3,501,733	4,287,259	$0.82
Georgia	$6,141,497	9,690,277	$0.63
Mississippi	$1,600,000	2,939,234	$0.54
Montana	$414,820	967,717	$0.43
Idaho	$312,000	1,526,295	$0.20
Alabama	$0	4,673,889	$0.00
Hawaii	$0	1,280,001	$0.00
Nevada	$0	2,612,460	$0.00
Utah	$0	2,724,685	$0.00

APPENDIX D: STATUS OF STATE EFFORTS TO ADDRESS UTILITY LOST REVENUES AND INCENTIVES FOR ENERGY EFFICIENCY[69]

State	Decoupling or Related Mechanism	Performance Incentive
Alabama	1 point. Lost revenue recovery in place for electric and gas - Alabama Power and Alabama Gas Company can recover lost revenues by projecting losses and adjusting rates annually through Rate RSE which includes caps and automatic rate reductions when profits or expenses exceed authorized ranges.	1.5 points. In place for gas and electric - Alabama Power and Alabama Gas Company may recover a reasonable rate of return on efficiency spending via a rate rider.
Alaska	0 points.	0 points.
Arizona	0.5 points. Lost revenue recovery pending for electric and decoupling pending for gas - Both Southwest Gas and Tucson Electric Power have proposed mechanisms.	1 point. In place for electric - Arizona Public Service has a tiered shareholder performance incentive.
Arkansas	1 point. Lost revenue recovery in place for electric and gas - All major, investor-owned utilities (IOUs).	0.5 points. Pending for electric and gas - In December 2010 the Public Service Commission approved incentives as a means to reward energy conservation by investor owned utilities.
California	1.5 points. Decoupling in place for electric and gas - All investor-owned utilities (IOUs).	1.5 points. In place for electric and gas – Investor-owned utilities participate in a risk/reward incentive mechanism.
Colorado	1 point. Partial decoupling in place for gas and disincentive offset in place for electric - In 2007 a partial decoupling three-year pilot mechanism was approved. The Public Service Company of Colorado has a disincentive offset.	1.5 points. In place for electric and gas – Incentive approved in 2008 for Public Service Company of Colorado and Black Hills.
Connecticut	1 point. Decoupling (pilot) for electric and lost revenue recovery for gas (gas decoupling pending).	1 point. In place for electric.
Delaware	1 point. Decoupling pending for electric and gas - Delmarva has applied for a form of decoupling for gas and electric, however the Public Service Commission has not yet issued a decision.	0 points.
District of Columbia	1 point. Decoupling for electric – Potomac Electric Power Company collects a Stabilization Adjustment. . Washington Gas Light has requested decoupling, but was denied.	1.5 points. In place for electric and gas – A third party administrator can earn a performance-based incentive.
Florida	0.5 point. Decoupling is pending for gas and lost revenue recovery is pending for electric - Electric utilities may request recovery of lost revenues via a rate case. Gas utilities may request decoupling.	0.5 point. Pending for electric and gas - Legislation has authorized an additional return on equity for energy savings in excess of goals in 2008, but no utilities have requested one.
Georgia	0.5 point. Lost revenue recovery for electric – Georgia	1 point. In place for electric – Georgia Power

[69] More detailed information is available on ACEEE's State Policy Database, www.aceee.org/sector/state-policy

State	Decoupling or Related Mechanism	Performance Incentive
	Power may recover lost revenues from implementing conservation programs via an "additional sum".	may earn a percentage of net benefits from electricity savings from the implementation of efficiency programs via an "additional sum".
Hawaii	1 point. Decoupling for electric – Decoupling was approved in 2010 for Hawaiian Electric Company companies.	1 point. Hawaii transferred administration of efficiency programs to a third-party administrator in 2009. An incentive for exceeding savings goals is available.
Idaho	1 point. Decoupling for electric – A Fixed-Cost Adjustment was approved for Idaho Power Company in 2007 and expires at the end of 2011.	0 points. A pilot program for Idaho Power Company was cancelled in 2009.
Illinois	1 point. Decoupling for gas - North Shore Gas and Peoples Gas and Coke are approved for revenue-per-customer decoupling pilots through 2011.	0 points.
Indiana	1 point. Decoupling for gas and electric and lost revenue recovery for electric - The Southern Indiana Gas Company and Electric Company, have decoupling. Vectren has a Reliability Cost and Revenue Adjustment Mechanism. Duke Energy Indiana has lost revenue recovery.	1.5 points. In place for electric and gas - Indianapolis Power & Light and Southern Indiana Gas & Electric Company have tiered shareholder performance incentives and Indiana Michigan Power Company has a shared benefits approach.
Iowa	0.5 points. Lost revenue recovery authorized for gas, but not in place - Utilities may request recovery of lost revenues on a case by case basis, though none currently have a mechanism in place.	0 points.
Kansas	0.5 points. Lost revenue recovery in place for electric and decoupling authorized for gas, but not in place - Utilities may request recovery of decoupling on a case by case basis, though none currently have a mechanism in place.	0.5 points. Authorized for electric and gas, but not in place - Utilities can request shared savings performance incentives on a case by case basis, however no plans have been approved.
Kentucky	1 point. Lost revenue recovery is in place for electric and gas utilities – The largest investor-owned utilities have a mechanism in place.	1.5 points. In place for electric and gas – Duke Energy, Louisville Gas & Electric and Kentucky Power (AEP) have shared savings mechanisms in place.
Louisiana	1 point. In place for electric and gas utility - In New Orleans there is a rate rider that provides for recovery of lost contribution to fixed costs for the electric and gas utility Entergy.	1.5 points. In place for electric and gas - In New Orleans there is a rate rider that provides an incentive to the electric and gas utility Entergy.
Maine	0.5 points. Decoupling authorized for electric and gas – Decoupling is authorized under statute, but not in place. Efficiency programs are implemented by a government agency.	0.5 points. Authorized for electric and gas, but not in place – Incentives are authorized under statute, but efficiency programs are implemented by a government agency.
Maryland	1.5 points. Decoupling in place for electric and gas – the three investor-owned utilities have decoupling in place.	0.5 points. Authorized for electric and gas, but not in place – Legislation authorizes incentives, but none have been

State	Decoupling or Related Mechanism	Performance Incentive
		approved.
Massachusetts	1.5 points. Decoupling in place for electric and gas – decoupling is implemented for all major gas and electric utilities.	1.5 points. In place for electric and gas – Shareholder incentives can be earned based on achievement of performance targets.
Michigan	1.5 points. Decoupling in place for electric and gas – Decoupling implemented for Consumers Energy, Detroit Edison, Michigan Gas Utilities and Michigan Consolidated Gas Company.	1.5 points. In place for electric and gas – Detroit Edison Company has an incentive in place.
Minnesota	1 point. Decoupling in place for gas and pending for electric – CenterPoint Energy has decoupling. Electric utilities are to submit proposals by the end of 2011.	1.5 points. In place for electric and gas – Incentives have been in place since 1999.
Mississippi	0 points.	0 points.
Missouri	0.5 points. Straight-fixed variable pricing in place for gas – Atmos Energy has been approved for a straight-fixed variable pricing structure. The state has approved rules for recovery of lost revenue.	0.5 points. Commission has authorized incentives, but none are currently in place.
Montana	1 point. Lost revenue recovery in place for electric and gas – NorthWestern Energy has a lost revenue recovery mechanism in place.	0.5 points. Statue allows an authorized rate of return, but none has been approved.
Nebraska	0 points.	0 points.
Nevada	1 point. Lost revenue recovery in place for electric. Full decoupling in place for gas – A lost revenue recovery mechanism was approved for NV Energy electric service in 2010.	0.5 points. 5% adder to ROE for electric utilities was eliminated in 2010 when lost revenue mechanism was created. Electric utilities may request an incentive on a program-by-program basis.
New Hampshire	0.5 points. The Public Utility Commission has authorized utilities to apply for decoupling or lost revenue recovery on a case by case basis.	1.5 points. In place for electric and gas – All utilities participate in the state incentive program.
New Jersey	0.5 points. Lost revenue recovery in place for gas, pending for electric - New Jersey Natural Gas Co. and South Jersey Gas Co. have a rate rider for collection of lost revenues. Atlantic City Electric and Rockland Electric Company have proposed a bill stabilization agreement that calls for monthly true-ups though a decision on the issue of lost revenues has been deferred.	0 points.
New Mexico	0 points. Lost revenue recovery pending for electric and gas – A rate rider had been approved to remove regulatory disincentives, however a recent court case overturned the mechanism. Legislation requires that regulatory disincentives to cost-effective efficiency be removed.	0.5 points. Pending for electric and gas – A rate rider had been approved to provide an incentive for efficiency, but was overturned by a recent court case. Rules adopted in April 2010 provide for a financial bonus to utilities for energy savings.

State	Decoupling or Related Mechanism	Performance Incentive
New York	1.5 points. Decoupling in place for electric and gas – Utilities are ordered to file proposals for decoupling mechanisms in ongoing and new rate cases.	1.5 points. In place for electric and gas – Incentive program is mandatory for electric utilities. A similar program exists for gas utilities, but they may opt out.
North Carolina	1.5 points. Decoupling in place for electric and gas, lost revenue recovery in place for electric – Duke Energy Carolinas has mechanisms in place which permit decoupling and recovery of lost revenues. Lost revenue recovery and decoupling have been approved for several additional utilities.	1 point. In place for electric – Progress Energy Carolinas and Duke Energy Carolinas have incentives in place.
North Dakota	0 points.	0 points.
Ohio	1 point. Lost revenue recovery in place for electric and gas – Utilities are permitted to recover lost revenues on a case-by-case basis.	1 point. In place for electric – Several electric utilities have incentives in place, including the Duke Save-A-Watt program. Columbia Gas has a shared savings mechanism pending approval.
Oklahoma	0.5 points. Lost revenue recovery in place for electric, but not gas – Both Public Service Oklahoma and Oklahoma Gas and Electric Company recover lost revenues.	1 point. In place for electric - Both Public Service Oklahoma and Oklahoma Gas and Electric Company have shared benefit incentive plans.
Oregon	1.5 points. Decoupling in place for electric and gas – Portland General Electric has a "Sales Normalization Adjustment". Cascade Natural Gas and Northwest Natural Gas have had mechanisms in place since 2006 and 2003, respectively.	0 points.
Pennsylvania	0 points.	0 points. Disincentive in place for electric – Electric utilities may be fined if they fail to meet their efficiency targets.
Rhode Island	1.5 points. Decoupling pending for electric and gas – National Grid has a decoupling proposal pending.	1.5 points. In place for electric and gas - Shareholder incentive for electric and gas since 2005 and 2007, respectively.
South Carolina	0.5 points. Lost revenue recovery in place for electric, but not gas – Duke, Progress and South Carolina Electric & Gas all have lost revenue recovery mechanisms in place.	1 point. In place for electric – Progress and South Carolina Electric & Gas have shared savings incentives. Duke has an avoided cost recovery plan.
South Dakota	1 point. Lost revenue adjustment for electric and gas – Northwestern Energy has a lost revenue recovery mechanism for both electric and gas. (GE09-001)	1.5 points. In place for electric and gas – Mechanisms have been approved for several utilities including OtterTail Power, MidAmerican, Montana-Dakota Utilities and Northwestern Energy.
Tennessee	0.5 points. Lost revenue recovery for gas – Chattanooga Gas Co. collects a monthly charge for fixed costs to align utility interests to better promote	0 points.

State	Decoupling or Related Mechanism	Performance Incentive
	efficiency.	
Texas	0 points.	1 point. In place for electric – All investor-owned utilities have a shared benefit incentive.
Utah	1 point. Decoupling for gas, electric pending – Questar Gas has tariffs that authorize revenue based on the number of customers served. Legislation encourages the Commission to remove financial disincentives to efficiency.	0.5 points. Legislation expresses support for incentives, but none have been authorized.
Vermont	1 point. Decoupling in place for electric, but not gas – Central Vermont Public Service has a decoupling mechanism that expires in 2011. Vermont Gas has an Alternative Regulatory Plan in place.	1 point. In place for electric – Vermont contracts an independent third party to operate efficiency programs. The contract includes a performance-based incentive.
Virginia	1 point. Decoupling in place for gas, lost revenue recovery pending for electric – Several gas utilities have decoupling. Dominion has applied for recovery of lost revenues, but was not approved.	0.5 points. Pending for electric – Legislation authorized incentives for electric utilities, though none have been approved.
Washington	1 point. Decoupling and lost revenue recovery in place for gas, but not electric –Cascade Natural Gas has decoupling in place. Avista has a lost revenue recovery mechanism in place.	0.5 points. Disincentive in place for electric - Electric utilities may be fined if they fail to meet their efficiency targets. Commission has issued guidance for utilities to request incentives.
West Virginia	0 points.	0 points.
Wisconsin	1 point. Decoupling in place for electric, lost revenue recovery in place for gas – Wisconsin Public Service Corporation received approval for decoupling in 2008. Wisconsin Electric Power Company's Gas Cost Recovery Mechanism was approved in 2011.	1.5 points. In place for electric and gas – Wisconsin Power and Light has a shared savings program.
Wyoming	1 point. Decoupling in place for gas, lost revenue recovery in place for electric – Questar Gas Company has a pilot decoupling mechanism. Montana-Dakota Utilities Company has a load management tracking adjustment mechanism.	0 points.

APPENDIX E: SUMMARY OF STATE BUILDING CODE STRINGENCY

State	Summary of State Building Code Stringency	Score
Alabama	Alabama has no mandatory state-wide code for residential or commercial buildings. The Residential Energy Code for Alabama (RECA) is voluntary and based on the 2006 IECC, except for the exclusion of the SHGC 0.40 requirement for glass windows. For commercial buildings, the Alabama Building Energy Conservation Code (ABECC), based on ASHRAE 90.1 – 2001, is only mandatory for government-owned buildings. Builders can use RECA and ABECC until June 1, 2009. For both residential and commercial buildings, the 2006 IECC can be used voluntarily as of December 1, 2008. On April 12 2011, both the residential energy subcommittee and the full membership of the Alabama Residential and Energy Codes Board approved a proposal to adopt a new residential energy code based on the 2009 IRC with strengthening amendments that would make it equivalent to the 2009 IECC. The Board had previously approved a new commercial code based on the 2009 IECC in January 2011. A public commenting period will follow along with a final vote by the board. The effective date is unknown.	4
Alaska	Alaska's residential code is the state-developed Building Energy Efficiency Standard (BEES), which is based on the 2009 IECC and ASHRAE Standard 62.2-2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, with Alaska-specific amendments. BEES is mandatory for state-financed residential construction projects, which covers roughly 25% of housing starts in the state (those that qualify for state financial assistance). Alaska has no statewide commercial building code, but all public facilities must comply with the thermal and lighting energy standards adopted by the Alaska Department of Transportation and Public Facilities mandated by AS44.42020(a)(14).	2
Arizona	There is no mandatory residential or commercial energy code in Arizona. For commercial structures, all state-funded buildings constructed after February 11, 2005 must achieve LEED Silver certification and meet the energy standards of ASHRAE 90.1-2004 as mandated by Executive Order 2005-05. Arizona is a home-rule state, meaning that codes are adopted and enforced on a local rather than state level. Lists of jurisdictions that have adopted codes can be found at the EERE and BCAP pages linked below.	2
Arkansas	Arkansas' residential and commercial building energy codes are mandatory state-wide and are based on the 2003 IECC. The Arkansas Energy Code, which applies to residential buildings, includes state-specific amendments. Arkansas' commercial building code also includes ASHRAE 90.1 – 2001. Newly constructed or remodeled public buildings must comply with ASHRAE 90.1-2007.	2
California	California's energy code is considered to be the most aggressive and best enforced energy code in the United States, and has been a powerful vehicle for advancing energy-efficiency standards for building equipment. Many specifications are performance-based, offering flexibility for designers. The code also stands out because it includes field verification requirements for certain measures and reports high compliance rates overall. The most recent code, effective January 1, 2010, is mandatory statewide and exceeds 2009 IECC standards for residential buildings and meets or exceeds ASHRAE/IESNA 90.1-2007 for commercial buildings.	5
Colorado	Colorado is a home rule state with a voluntary building code for both residential and commercial construction with the 2003 IECC as a mandatory minimum for jurisdictions that have adopted a code previously. Jurisdictions that have not adopted or enforced codes are exempt from the 2003 IECC requirement, although the 2009 IECC is mandatory for all factory-built and multi-family structures – commercial and residential – in areas that do not adopt or enforce buildings codes. A list of jurisdictions that have adopted codes can be found at the EERE and BCAP pages linked below.	2
Connecticut	Connecticut has statewide codes for both residential and commercial buildings based on the 2009 IECC. On January 28, 2009, HB 6284 was	4

State	Summary of State Building Code Stringency	Score
	introduced in the Connecticut General Assembly with the purpose of creating a new state building energy code and green buildings for certain construction projects. The House passed the bill on May 26, 2009 and the Senate followed on June 2, 2009. The bill requires the incorporation of the 2012 IECC within 18 months of its publication. Effective July 1, 2010, the bill requires a LEED-Silver rating for certain residential buildings that are projected to cost $5 million or more as well as for renovation to certain residential buildings that are projected to cost $2 million or more.	
Delaware	Through the passing of SB 59 and effective July 1, 2010, Delaware's residential and commercial codes were updated to follow the 2009 IECC.	4
District of Columbia	Washington D.C.'s energy codes are mandatory across the District. For residential buildings, builders must comply with the 2008 D.C. Construction Codes, which is based on the "30% Solution" and is more stringent than the 2009 IECC. For commercial buildings, builders must again comply with the 2008 D.C. Construction Codes, which is based on ASHRAE 90.1-2007.	4.5
Florida	Florida has a state-developed mandatory code, Chapter 13 of the Florida Building Code, which directs residential construction to meet/exceed the 2006 IECC and commercial construction to meet/exceed ASHRAE 90.1 – 2004. In 2008, Governor Charlie Crist signed HB 697, which requires the Florida Building Commission to select the most current version of the IECC as a foundation code, but must modify it to maintain the thermal efficiencies of the Florida Energy Efficiency Code for Building Construction adopted and amended pursuant to § 553.901. The state-specific modifications will require improvements equivalent to the 2009 IECC for Florida's commercial sector, though a recent report by the Florida Solar Energy Center determined that the requirements for residential buildings will generate efficiency gains 3% below the 2009 IECC. The 2010 Florida Building Code, which will become effective March 15, 2012, will update the state code to be at least as stringent as the 2009 IECC for residential construction and ASHRAE 90.1-20007 for commercial construction.	4
Georgia	On January 1, 2011, the 2011 Georgia State Minimum Standard Energy Code became effective statewide as approved by the Georgia Department of Community Affairs on November 3, 2010. The state code is based on the 2009 IECC with state-specific strengthening amendments and is mandatory statewide. The commercial codes also reference ASHRAE 90.1-2007. The state also adopted the 2011 Georgia State Minimum Residential Green Building Standard, based on the 2008 National Green Building Standard (NGBS) with 2011 Georgia Amendments, as an optional code. It is available for local government adoption and enforcement.	5
Hawaii	On October 13, 2009, the Hawaii Building Code Council approved the 2006 IECC with state-specific amendments as the mandatory statewide energy code for both the residential and commercial sectors. The code will become law once an Administrative Directive is approved, which is expected to be signed soon by Governor Linda Lingle. Counties of Hawaii can modify the statewide code, as long as the codes are at least as stringent as the statewide code.	4
Idaho	Effective January 1, 2011, the 2009 IECC is mandatory statewide for residential and commercial construction, the latter with reference to ASHRAE 90.1-2007.	4
Illinois	The Illinois Energy Conservation Code is mandatory statewide and incorporates the 2009 IECC for all residential buildings 3 stories or fewer in height. Commercial buildings, privately or publicly funded, must comply with the 2009 IECC with reference to ASHRAE Standard 90.1-2007.	4
Indiana	The Indiana Energy Conservation Code is state-developed and mandatory statewide. For residential buildings, the code is equivalent to the 1992 MEC, but the code has been repealed and, as of mid-2010, the state Fire Commission has been working on updating the code to the 2009 IECC. For commercial buildings (commercial and residential buildings with three or more dwelling units) the code references ASHRAE standard 90.1-2007 as of May 6, 2010. Executive Order 08-14, signed by Governor Charlie Daniels on June	3.5

State	Summary of State Building Code Stringency	Score
	28, 2008, requires all new state buildings to earn LEED silver certification.	
Iowa	The Iowa State Energy code is mandatory statewide for residential and commercial buildings. Residential buildings must comply with the 2009 IECC, while the commercial buildings must also comply with the 2009 IECC, with reference to ASHRAE 90.1 – 2007.	4
Kansas	Kansas has no statewide residential building code, though realtors and homebuilders are required to fill out an energy-efficiency disclosure form and provide it to potential buyers. And although the commercial building code specifies the 2006 IECC as mandatory statewide, there is no enforcement mechanism in the statute (KSA 66-1227). The same statute also states that "the state corporation commission has no authority to adopt or enforce energy efficiency standards for residential, commercial, or industrial structures."	1
Kentucky	The 2007 Kentucky Residential Code (KRC) mandates residential buildings must comply with the 2006 IECC or IRC with state amendments while the 2007 Kentucky Building Code (KBC) states that commercial construction must comply with the 2009 IECC or the 2009 IBC with state amendments.	3.5
Louisiana	Residential buildings must meet the 2006 IRC with reference to the 2006 IECC. ASHARE/IESNA 90.1-2004 is mandatory for commercial buildings while the 2006 IECC is mandatory for those buildings not covered by ASHRAE, i.e. all multi-unit low-rise (3 or fewer stories) residential buildings.	3
Maine	The Maine Uniform Building and Energy Code (MUBEC) was established legislatively in April 2008 through P.L. 699. On June 1, 2010, the 2009 IECC and ASHRAE 90.1-2007 became mandatory for residential, commercial, and public buildings statewide. Towns with a population less than 4,000 are not required to enforce the code. According to the Northeast Energy Efficiency Partnership, this exempts 50-60% of the state's population.	4
Maryland	The 2010 Maryland Building Performance Standards are mandatory statewide and require both the residential and commercial building codes to comply with the 2009 IECC, the latter with reference to ASHRAE 90.1-2007. § 12-503 of the Maryland Code requires the Department of Housing and Community Development to adopt the most recent version of the IECC twelve (12) months after it is issued and may adopt energy conservation requirements that are more stringent than the codes, but may not adopt energy conservation requirements that are less stringent. Currently, Maryland is on track to adopt the 2012 IECC for both residential and commercial buildings by January 1, 2012.	5
Massachusetts	As of January 1, 2010, the Massachusetts Board of Building Regulations and Standards (BBRS) requires use of the 2009 IECC with state-specific amendments for both residential and commercial buildings, mandatory statewide. Massachusetts is required by the Green Communities Act of 2009 to adopt each new IECC edition within one year of its publication. In July 2009, Massachusetts became the first state to adopt an above-code appendix to its state code – the 120 AA 'Stretch' Energy Code. The 'Stretch' Code is an enhanced version of the 2009 IECC with greater emphasis on performance testing and prescriptive requirements. It was designed to be approximately 20 percent more efficient than the base energy code – the 2009 IECC for new construction, with less stringent requirements for residential renovations. The 'Stretch' Code is voluntary.	5
Michigan	The 2009 Michigan Uniform Energy Code became effective March 9, 2011 and is mandatory statewide for residential and commercial buildings. Residential buildings must comply with the 2009 IECC, with state-specific amendments. Commercial buildings are required to comply with ASHRAE 90.1-2007.	4
Minnesota	Both Minnesota's residential and commercial building codes, the 2007 Minnesota State Building Code, are mandatory statewide. The residential code (Chapter 1322) is based on Chapter 11 of the 2006 IRC with amendments. The commercial code (Chapter 1323) is based on ASHRAE 90.1-2004 with amendments. The 2007 Minnesota State Building Code became effective June 1, 2009.	3
Mississippi	Mississippi's residential and commercial energy codes are voluntary, except	0

State	Summary of State Building Code Stringency	Score
	for state-owned buildings, public buildings, and high-rise buildings. Mississippi's residential code is based on ASHRAE 90 – 1975 and the prior 92 MEC. The commercial code is also based on ASHRAE 90-1975.	
Missouri	Missouri has no mandatory state-wide codes but has significant adoption of codes in major jurisdictions. State-owned residential buildings must comply with latest edition of the MEC or the ASHRAE 90.2-1993 (single-family and multifamily buildings). As of July 1, 2009, state-owned commercial buildings must comply with the 2006 IECC.	2
Montana	Montana's residential and commercial building codes, codified in ARM Title 24, Chapter 301.160, are mandatory statewide. Montana's residential code requires compliance with the 2009 IECC with amendments. The commercial building code requires compliance with the 2009 IECC with reference to ASHRAE 90.1-2007.	4
Nebraska	Nebraska's residential and commercial energy codes are mandatory statewide. Residential buildings are required to comply with the 2009 IECC. Commercial buildings must also comply with the 2009 IECC with reference to ASHRAE 90.1 – 2007.	4
Nevada	Both the residential and commercial building codes are based on the 2006 IECC and are mandatory for jurisdictions without energy codes, with reference to ASHRAE 90.1-2004 for commercial buildings.	4
New Hampshire	Effective April 1, 2010, the New Hampshire State Building Code for residential and commercial buildings is based on the 2009 IECC, with state-specific amendments. The commercial code is also based on the 2009 IECC with references to ASHRAE 90.1-2007. Both codes are mandatory statewide.	4
New Jersey	The 2009 New Jersey Uniform Construction Code for residential and commercial buildings is mandatory statewide. The residential codes are based on the 2009 IECC with state-specific amendments. The commercial codes are based on ASHRAE 90.1-2007 with state-specific amendments.	4
New Mexico	In June 2011, the New Mexico Construction Industries Commission (CIC) repealed the 2009 New Mexico Energy Conservation Code (NMECC) and other construction codes the Commission adopted in 2010. The CIC had originally adopted a 2009 NMECC version containing strengthening amendments to the 2009 IECC that achieved savings roughly 20% greater than the 2006 IECC. In early 2011, the NMECC was subject to administrative rollback attempts and an ultimately successful advocate legal challenge. In April 2011, the CIC gave initial approval to the proposed changes to the NMECC that would revert the code back to the base 2009 IECC code, with final approval in June 2011. The previous version of the NMECC, which was based on the 2006 IECC, will be effective until the revised version from June 2011 takes effect in February 2012.	4
New York	The 2010 Energy Conservation Construction Code of New York (ECCCNYS) became effective December 28, 2010, and is mandatory statewide for both residential and commercial buildings. The residential code is based on the 2009 IECC with state-specific amendments. The commercial code is also based on the 2009 IECC with state-specific amendments. The commercial codes can also follow ASHRAE 90.1-2007.	4
North Carolina	The 2009 North Carolina Energy Conservation Code (NCECC) is mandatory statewide for both residential and commercial buildings. The residential and commercial codes are based on the 2006 IECC with amendments, while the commercial code also references ASHRAE 90.1-2004. The 2012 NCECC becomes effective January 1, 2012 and will be based on the 2009 IECC.	4
North Dakota	North Dakota has no statewide mandatory energy codes. As of August 1, 2009, the 1993 MEC was removed as the voluntary state residential energy code and ASHRAE 90.1-1989 was removed as the voluntary state commercial energy code. The voluntary energy code has been placed under the purview of the North Dakota State Building Code and now the state Building Code Advisory Committee now has the authority to make recommendations that could include energy standards future editions of the State Building Code. Chapters 11 and 13 of the 2009 IRC and IBC are contingent upon adoption by local jurisdictions.	0

State	Summary of State Building Code Stringency	Score
Ohio	Both Ohio's residential and commercial energy codes are mandatory statewide. The residential code is based off the 2006 IECC. Builders are also allowed to meet the requirements of sections 1101-1103 of Chapter 11 of the Residential Code of Ohio (based on Chapter 11 of the 2006 IRC) or by meeting the state code's new Prescriptive Energy Requirements (section 1104). In March 2011, the commercial code was amended to reference the 2009 IECC and ASHRAE 90.1-2007, with an expected effective date in September 2011.	3.5
Oklahoma	Oklahoma is a “home rule” state and has no mandatory statewide codes. The 2009 IRC is mandatory for jurisdictions without their own codes and for state-owned and –leased facilities.	1
Oregon	The 2011 Oregon Residential Specialty Code (ORSC) and the 2010 Oregon Energy Efficiency Specialty Code (OEESC) are mandatory statewide. The Oregon Building Codes Division recently issued a rulemaking updating the residential code to the 2011 ORSC (from the 2008 ORSC), which is intended to achieve 10-15% greater savings than the 2008 ORSC, making it at least as stringent as the 2009 IECC. The OEESC is based off of the 2009 IECC with state amendments that make it more stringent than the 2009 IECC.	5
Pennsylvania	Both Pennsylvania's residential and commercial energy codes are mandatory statewide. The residential buildings must comply with the 2009 IECC or 2009 IRC, Chapter 11. Residential buildings can also comply with Pennsylvania’s Alternative Residential Energy Provisions (2009). Commercial buildings must also comply with the 2009 IECC, with reference to ASHRAE 90.1 – 2007. Legislation requires the Pennsylvania Department of Labor and Industry (DLI) to promulgate regulations adopting "a new triennial BOCA National Building Code, or its successor building code," and/or "a new triennial ICC International One and Two Family Dwelling Code" by December 31st of the year in which they are issued. However, on January 31, 2011, HB 377 was introduced that would amend the Uniform Construction Code Act of 199 to require a 2/3 approval for any code update proposals by the DLI, along with other weakening amendments to the codes. The bill was signed by Governor Tom Corbett on April 25 as Act 1. The UCC has been subject to rollback attempts before in both the legislature and state courts.	4
Rhode Island	The 2010 Rhode Island One and Two Family Dwelling Code for residential buildings became effective July 1, 2010 and is based on the 2009 IRC with state-specific amendments. The 2010 Rhode Island State Energy Conservation Code for commercial buildings also became effective July 1, 2010, and is based on the 2009 IECC and ASHRAE 90.1-2007 with state-specific amendments. Both codes are mandatory statewide.	4
South Carolina	South Carolina's residential and commercial energy codes are mandatory statewide. All new residential and commercial buildings must meet the 2006 IECC.	3
South Dakota	South Dakota has no mandatory statewide energy codes for residential or commercial construction. Codes are adopted by jurisdiction voluntarily; the 2006 IECC is voluntary for new residential buildings. All state facilities are contractually required to be built to the ASHRAE 90.1-1999 standard.	0
Tennessee	Tennessee is a home rule state, which gives jurisdictions the power to adopt codes. On June 2, 2011, the Tennessee State Fire Marshal’s Office announced that it would begin the implementation and enforcement of adopted energy codes beginning July 1, 2011. These include ASHRAE Standard 90.1-2007 for all state buildings and the 2006 IECC for all other residential and commercial construction.	3
Texas	Texas' building codes are mandatory for both residential and commercial construction. In June 2010, the Texas State Energy Conservation Office (SECO) officially adopted a rule to update the state's energy codes codified in 34 TAC §19.53. The rule will update the Texas Building Energy Performance Standards so that single family homes will have to comply with the 2009 IRC beginning January 1, 2012. For all other residential, commercial, and industrial buildings, the 2009 IECC became effective April 1, 2011. State-owned buildings must meet ASHRAE 90.1-2007. For all buildings,	4

State	Summary of State Building Code Stringency	Score
	jurisdictions can choose to adopt more stringent standards.	
Utah	Utah's Uniform Building Code (UUBC) for residential and commercial building energy codes is mandatory statewide. Residential construction must comply with the 2006 IECC. Commercial construction must comply with the 2009 IECC, with reference to ASHRAE 90.1-2007.	3.5
Vermont	Vermont's Residential Building Energy Standard (RBES) is a statewide code based on the 2000 IECC with state-specific amendments that is mandatory for residential buildings. The 2005 Guidelines for Energy Efficient Commercial Construction is based on the 2004 IECC Supplement with amendments to include ASHRAE 90.1-2004 and state-specific amendments. On May 27, 2009, the state legislature passed the Vermont Energy Act of 2009 (H. 466), which directs the Commissioner of the Department of Public Service (DPS) to adopt the 2009 IECC and ASHRAE 90.1-2007 as well as develop a plan to achieve 90% compliance within eight years. The bill directs the Department of Public service to complete a rulemaking on the adoption of the 2009 IECC for residential buildings and either the 2009 IECC or ASHRAE 901.-2007 for commercial buildings by January 1, 2011, effective upon final adoption. On July 1, 2011, the DPS officially updated the 2011 RBES to reference the 2009 IECC with strengthening amendments. The new residential code becomes effective October 1, 2011. DPS is still working on updating the 2011 CBES to reference the 2009 IECC and ASHRAE 90.1-2007 with several strengthening amendments from the 2012 IECC.	4
Virginia	Virginia's Uniform Statewide Building Code (USBC) is mandatory statewide for residential and commercial buildings. As of March 1, 2011, the USBC was updated to reference the 2009 IECC and 2009 IRC, with a one-year phase-in where builders and designers can still use the previous version of the USBC. Residential buildings must comply with the 2009 IRC, while commercial buildings must comply with the 2009 IECC, with reference to ASHRAE 90.1-2007.	3.5
Washington	The 2009 Washington State Energy Code is a state-developed code that is mandatory statewide. The 2009 version of the residential code was developed to be as stringent as the 2009 IECC, while the commercial code was developed to be as stringent as ASHRAE 90.1-2007. For residential construction covered by ASHRAE 90.1-2007 (high rise buildings with four or more stories), the state code is more stringent.	5
West Virginia	West Virginia's residential and commercial building codes are mandatory statewide; however, adoption by jurisdictions is voluntary. Residential buildings are required to comply with the 2003 IECC and the 2003 IRC with amendments. Commercial buildings are required to comply with the 2003 IECC with amendments. On April 11, 2009, the West Virginia Legislature passed bills directing the State Fire Commission to promulgate rules adding the 2009 IECC and ASHRAE 90.1-2007. The updated codes have not yet become effective.	2
Wisconsin	Both Wisconsin's residential and commercial building energy codes are mandatory statewide. The state-developed residential code, referred to as COMM 22 of the Uniform Dwelling Code (UDC), is mandatory for one- and two-family dwellings and incorporates the 2006 IECC with state amendments. The state-developed commercial code, referred to as COMM 63 of the Wisconsin Commercial Building Code, is based on the 2009 IECC.	3.5
Wyoming	Wyoming's residential and commercial building codes are voluntary. Known as the ICBO Uniform Building Code, they are based on the 1989 MEC and may be adopted and enforced by local jurisdictions.	0

APPENDIX F: SUMMARY OF STATE BUILDING CODE COMPLIANCE EFFORTS

State	Summary of State Building Code Compliance Efforts	Score
Alabama	Auburn University published a study in 2008 that determined very few jurisdictions have adopted a version of the IECC, while some have adopted the International Residential Code and modified the energy chapter to be less stringent. Energy codes for private sector residential and commercial construction are enforced by local code officials in several jurisdictions. Many smaller jurisdictions currently have no code enforcement. Through a joint contract with the Mississippi Energy Office in 2007, the Energy Division of the Alabama Department of Economic and Community Affairs has been providing workshops for homebuilders, contractors, engineers, and subcontractors. The Code Officials Association of Alabama also provides training to code officials. In 2011, the state energy office provided commercial and residential energy codes training. Additionally, an 18-month grant with Southface Energy Institute has offered training in residential and commercial energy codes for code officials, contractors, designers and policy makers.	0.5
Alaska	While Alaska has no statewide energy code, all buildings that receive aid from the state of Alaska or the Alaska Housing Finance Corporation (AHFC) (including private mortgages) must meet the 2009 IECC codes with Alaska specific amendments. These buildings are fitted with energy rating systems to verify compliance. Currently roughly 50,000 of the 300,000 residences in Alaska are outfitted with these ratings systems. AHFC trains energy raters and home inspectors to monitor enforcement of these requirements.	0
Arizona	We currently have no detailed information on compliance rates in Arizona. Arizona's score is based on expert judgment on compliance rates.	1
Arkansas	The latest study completed to measure compliance was published in 2006 by the Arkansas Economic Development Commission. Results indicated that compliance with the code is increasing, but more attention was needed in the colder, northwest part of the state. Enforcement is a major issue that varies with each jurisdiction. Enforcement is more common in larger cities with greater resources, but the focus of building inspections tends to be on structural integrity, fire, water, and safety. Builders and code officials periodically receive training on code compliance, typically through the Code Officials of Arkansas and the AR Economic Development Commission.	0.5
California	No studies have been conducted or funding identified to establish a baseline of compliance in California. Enforcement is at the local level and there are building departments in each of the 536 city and counties. Online training is available at www.energyvideos.com. Utilities, the California Energy Commission staff and local organizations and trade groups provide training to these building departments as well as to contractors and homeowners.	2
Colorado	The Governor's Energy Office (GEO) recently completed the Building & Energy Code Survey Report, which presents the results of a July 2009 survey on building code enforcement and adoption, as well as a needs assessment for the types of code assistance desired in the 333 code jurisdictions. Results from the survey indicate that 80% of respondents (n=174) claim to be enforcing residential codes and 79% commercial codes, though this is not a measure of compliance. The GEO has provided over 45 trainings on the 2003/6/9 IECC over the past 1.5 years and has been providing training for the last 3 years. The survey indicates that 84% of respondents requested additional support from the state energy office on energy codes.	1.5
Connecticut	The Office of Education and Data Management (OEDM) has done a series of surveys in 2008-2009 on code training needs of local architects, designers, and building contractors to facilitate more uniform compliance. A baseline energy code compliance survey was conducted in late 2010 and early 2011 by OEDM with the Institute for Sustainable Energy at Eastern Connecticut State University, with results currently under review. Codes are enforced through the local building code enforcement official. The OEDM in conjunction with the Office of the State Building Inspector are responsible for the training and licensing of building code officials. Training is common as building inspectors must receive a minimum number of continuing-education credits per year. Once	1.5

State	Summary of State Building Code Compliance Efforts	Score
	licensed, code officials must attend 90 hours of code related continuing-education programs within a three-year cycle.	
Delaware	We currently have no detailed information on compliance rates in Delaware. Delaware's score is based on expert judgment on compliance rates.	1
District of Columbia	The codes are enforced by the codes division of the Department of Consumer and Regulatory Affairs (DCRA), which regularly trains its official on code updates.	1
Florida	No studies have been conducted that attempt to measure compliance rates in the state, though the state plans to perform a study measuring the relative building performance between the implementation of the 2007 Florida Building Code and the 2009 Supplement. Enforcement is done at the local level by building departments with code clarifications issued by the Building Officials Association of Florida (BOAF), while Declaratory Statements are issued by the Florida Building Commission. Building departments receive training at the annual BOAF conference. Code officials and those in the construction industry are also required to take continuing education courses. The Florida Solar Energy Center has a contract to develop a Train-the-Trainer program and online web training to radically expand the number of persons qualified on Florida's energy code.	1.5
Georgia	The most recent survey on compliance was conducted by the Department of Community Affairs in 2004, which showed that about 50% of counties were enforcing the Georgia State Energy Code, though the study did not actually measure compliance. Currently there is no organized training program, though a comprehensive state-wide training program is expected to begin in late 2010. Local jurisdictions may request training from the Department of Community Affairs' Construction Codes program. As one of the 24 states to receive funding from DOE for bolstering its compliance efforts as well as being one of the nine states to receive funding for a compliance pilot study, which is currently underway, the state has been able to make considerable progress in strengthening its overall compliance efforts.	1.5
Hawaii	The last study completed that measured compliance was done in 1999 and determined a compliance rate of 89%. Each of the four counties in HI has a Building Division within the Public Works departments. State government buildings and military housing voluntarily comply with the county codes. Code officials receive training when a new code is imminent, such as in 2009 when several counties were about to adopt the IECC 2006 or 2009.	1
Idaho	The last study measuring compliance in Idaho was conducted in 2008 and was based on the 2001 Idaho energy code, which at the time followed the 1997 Uniform Building Code. At the time, compliance was measured at 88%. Training is scheduled each year through the Idaho Building Official Association (IDBAO). The IDABO also holds a two-day course on IECC training every January while the Idaho Energy and Green Building Conference every October also has a two-day training course. In 2010 there will be six educational seminars for builders, designers, and code officials that will provide continuing education credits for members of the American Institute of Architects and IDBAO.	2
Illinois	Illinois recently completed a compliance study using a grant from the Department of Energy and contracting through the Midwestern Energy Efficiency Alliance; results are due in August 2011. Enforcement of codes is mandatory under state law and is enforced by local authorities. Training is provided by the Illinois Department of Commerce and Economic Opportunity through funding from the International Code Council.	1
Indiana	There are no recent studies that have attempted to measure compliance rates with the Indiana Energy Conservation Code. Codes are enforced at the state and local level for all buildings except single and dual-family dwellings, which are enforced only at the local level. Code officials receive training through their employment with the Division of Fire and Building Safety of the IN Department of Homeland Security. The Indiana Builders Association also provides training, and the Indiana Office of Energy and Defense Development has offered training sessions to several groups as well.	0.5

State	Summary of State Building Code Compliance Efforts	Score
Iowa	Enforcement takes place at the state and local levels. A 2009 survey determined enforcement varies from 0-40% of jurisdictions, though smaller jurisdictions often do not enforce codes. This survey, however, did not attempt to measure compliance. A recent grant from the American Recovery and Reinvestment Act from the Iowa Office of Energy Independence to the Iowa Department of Public Safety will allow for the hiring of an engineer and building inspector to start a more active approach to energy code enforcement in Iowa. There is no mandatory training program in Iowa, but the Iowa Association of Building Officials (IABO) provides several seminars each year on a variety of code enforcement topics. Investor Owned Utilities also provide some energy code training throughout the year. The State Building Code Bureau and IABO are planning to host three 2-day seminars throughout Iowa in the summer of 2010, which will provide specific energy code training to all code officials on the 2009 IECC.	1
Kansas	In 2010 the Kansas Energy Office surveyed 55 Kansas cities in an attempt to better understand the enforcement of the codes throughout the state. Results were mixed and did not reveal a specific percentage of compliance. There is no provision for enforcement, though as a home rule state, Kansas allows local jurisdictions to enact local regulations where a statewide standard does not exist. The Energy Efficiency Building Codes Working Group was set up in 2009 to ensure compliance with federal guidelines surrounding stimulus funds and plans to address the need for code training, the level of which varies across jurisdictions. Currently, the State does not play a direct role in training codes officials and builders about codes.	0.5
Kentucky	There are no recent studies that have attempted to measure code compliance in the state. Enforcement is done at the state and local level by building inspection departments. The Department of Housing, Building, and Construction co-sponsored 20 days of training in 2008, while the efforts of several independent groups likely increased that to 30 days.	1
Louisiana	There are no recent studies that have attempted to measure code compliance in Louisiana. Enforcement of the residential code is done by the Certified Building Official in each of the 64 parishes. Commercial codes are enforced by the Office of the State Fire Marshall. Code officials receive training through the International Code Council seminars and online courses. The Technology Assessment Division (TAD) travels statewide teaching code software targeted towards designers, builders, code officials, architects, engineers and owners, which can also count as continuing education credits. In 2009, 412 individuals attended TAD training programs. Building inspectors are trained through the Department of Natural Resources.	1
Maine	A study on compliance was conducted by the Maine Public Utilities Commission in 2008, though a copy of the study cannot be found on their website. Only towns with more than 2,000 residents are required to enforce the 2009 IECC. A training and certification program was launched simultaneously with the building energy code changes. All code officers are required to be certified and training is provided free of charge. Builders, architects and others are not required to be certified, but are encouraged to attend the training on a fee basis.	0.5
Maryland	There are no recent studies that have attempted to measure code compliance in Maryland. Codes are enforced by each local jurisdiction through their Department of Codes Enforcement and Permits and Inspections. Approximately 900 building inspectors from every jurisdiction, along with 400 architects and 300 building contractors are trained every year through the Department of Housing and Community Development.	0.5
Massachusetts	A 2006 study measured compliance with the MA State Building Code was completed by the BBRS and focused solely on the residential sector. In 2010 the Dept. of Energy Resources and the electric and gas program administrators teamed up to update the residential baseline study with a sample of 40 homes built to the IECC2006 code and another 40 built to the new IECC2009 code. Results will be published the latter half of 2011. The BBRS, Department of Energy Resources (DOER) and other partners are planning a pilot evaluation of residential energy performance and code compliance that intends to inform how states determine code compliance rates. Enforcement is performed by local	2

State	Summary of State Building Code Compliance Efforts	Score
	building code officials. In cities that have elected to adopt the state's 'stretch' energy code, enforcement of the building energy code is greatly assisted by the role of HERS raters. The BBRS has technical staff that provides advice and training to local code officials and works with regional organizations of local code officials to discuss enforcement issues. The state requires that all code officials fulfill a set of certification requirements in all aspects of construction and code enforcement, which includes continuing education through certified courses. The Green Communities Act requires the BBRS and the Department of Energy Resources to develop specific energy efficiency training and certification for all local code officials. Consequently, the DOER sponsored 40 trainings in 2010 on building energy codes and building science, and in 2011 these trainings have evolved into more practical 'Smart Building' trainings covering best practices for builders and code officials.	
Michigan	There are no recent studies that have attempted to measure code compliance in Michigan. Enforcement is under the auspices of the state government as established by the Stille-DeRossett-Hale Single State Construction Code Act, but governmental subdivisions may exempt themselves from state enforcement by setting up an enforcement agency themselves. Code officials are required to receive continuing education under the Building Officials and Inspectors Registration Act. A number of code official organizations provide regular training throughout the state. The Bureau of Construction Codes also provides code training.	0.5
Minnesota	There are no recent studies that have attempted to measure code compliance in Minnesota. Enforcement takes place at the local level. Training is provided in the spring and fall by the Department of Labor and Industry.	1
Mississippi	Because Mississippi has no statewide building energy codes, all residential and commercial codes are carried out at the local jurisdictional level. However, the Mississippi Development Authority's Energy Division has recently held workshops on building energy codes.	0
Missouri	We currently have no information on compliance rates in Missouri.	0
Montana	The Building Codes Bureau in the Department of Labor and Industry (L&I) is responsible for compliance checks within the commercial sector. The last study measuring compliance in Montana was conducted in 2008 by the Northwest Energy Efficiency Alliance and was based on the code enforced in 2001, which was ASHRAE 90.1-1989. At the time, compliance was measured at 47%. A residential code compliance study is currently underway; results will be available by November 2011. A residential code compliance study is currently underway with results due in the Fall of 2011. The Montana Department of Labor and Industry (L&I) coordinates code adoption and enforcement, although the residential energy code is enforced by the 46 local jurisdictions and most major cities enforce the energy code within their city limits. Builders are required to meet code requirements and show compliance through a builder self-certification process. Residential projects built outside of building code jurisdictional areas are not inspected, but the state provides information to builders to comply with code standards. L&I enforces compliance on commercial buildings and residences of more than 5 units that are located outside of jurisdictional areas. L&I provides some training, but the Department of Environmental Quality (DEQ) provides more training support in the form of workshops and on-site training sessions to code officials and builders. DEQ also participates with the state Building Codes Bureau in an annual code training conference on all ICC codes.	1.5
Nebraska	Nebraska is currently undertaking a baseline compliance study. Local jurisdictions that adopt and enforce an energy or thermal efficiency code are required by statute to adopt a code that meets or exceeds the minimum requirements of the Nebraska Energy Code. Otherwise, enforcement of the code falls to the Nebraska Energy Office. Since 2004, the NE Energy Office has provided energy code compliance and education opportunities across the state. More than 1,100 members of the state's construction industry have been trained on the code requirements. To date, in 2011 eleven trainings have been	1

State	Summary of State Building Code Compliance Efforts	Score
	provided from ICC, ASHRAE and other members of the building science community.	
Nevada	We currently have no detailed information on compliance rates in Nevada. Nevada's score is based on expert judgment on compliance rates.	1
New Hampshire	A Gap Analysis study was completed in 2011, which looks into the current state of code implementation and offers suggestions to increase compliance. The state is also in the process of conducing a statewide compliance study. Building codes are enforced at the local level by the municipality with the Public Utilities Commission (PUC) reviewing applications for many cities and towns. In 55 of New Hampshire's municipalities, the fire department handles building code enforcement, focusing mainly on life-safety issues. The PUC, in coordination with the state's regulated electric utilities, GDS Associates, and the state Office of Energy and Planning, conduct energy code trainings in the fall and spring that are designed to teach builders, designers, engineers, and building officials how to build to code and beyond. New Hampshire has also increased outreach and training to "nontraditional" audiences, such as realtors, appraisers, lenders, and insurers. The Office of Energy and Planning is developing a program on Building Code Compliance using stimulus funds, which will specifically develop and implement training programs for code officials to achieve 90% verifiable compliance by 2017.	1.5
New Jersey	There are no recent studies that have attempted to measure code compliance in New Jersey. Enforcement is done at the local level through permits and inspections. Code officials are required to take continuing education courses, and license renewal through the Department of Community Affairs is required every three years.	0.5
New Mexico	There are no current studies that have attempted to measure code compliance in New Mexico. Codes are enforced by the NM Regulations and Licensing Department and by local governments. Code officials receive training through the Construction Industries Division on a regular basis and there are plans to use stimulus funds to ramp-up these training programs.	0.5
New York	The New York State Research and Development Authority (NYSERDA) is developing Request for Proposals for baseline energy code studies in order to identify where the most improvement is needed. Building energy codes are enforced at the local level by municipalities through the process of building permit and inspection. Code officials are required to complete annual code update training, which includes a training component specific to the energy code. Additional training has been given throughout the state by the NYS Building Official's Conference, which is given by the NYS Code promulgation staff. Comprehensive energy code courses have been conducted statewide by ERS Energy Consultants. There are also plans to leverage stimulus funding to develop widespread energy code training courses.	2
North Carolina	There are no recent studies that have attempted to measure code compliance in North Carolina. Enforcement is the obligation of local jurisdictions through the permit/inspection process for new construction and additions. The NC Department of Insurance is responsible for the general supervision statewide. Appalachian State University and Mathis Consulting have coordinated to put together over 30 workshops over the past 3 years, targeting training for specific jurisdictions. The NC Department of Insurance also provides training as a part of its annual workshops for building inspectors and mechanical inspectors.	1
North Dakota	We currently have no information on compliance rates in North Dakota.	0
Ohio	The Ohio Energy Office conducted a study measuring enforcement in 2005, although there are no recent studies that have attempted to measure code compliance in Ohio. The Ohio Board of Buildings Standards (BBS) adopts statewide energy codes and certifies the building departments and the personnel working for the departments throughout the state who enforce the codes. Code officials are required to take 30 hours of continuing education every three years to maintain their certification. There are other optional energy code courses that have been approved by the BBS so that the code officials can receive continuing education credits to be used to fulfill their 30-hour requirement, which includes an online energy code course.	0.5

State	Summary of State Building Code Compliance Efforts	Score
Oklahoma	There are no recent studies that have attempted to measure compliance rates in Oklahoma. Because Oklahoma is a "home rule" state, enforcement is the onus of the municipality that has adopted an energy code. Code officials are trained by the Oklahoma Construction Industry Board (CIB). The Inspectors Examiners Committee has the authority to "assist" the CIB in establishing licensing, performance, continuing educations and other requirements for inspectors. Because Oklahoma has not yet adopted statewide energy codes, training is coordinated by municipalities instead of at the state level.	0.5
Oregon	In 2011, the Building Codes Division (BCD) conducted a preliminary 90% compliance study through the Northwest Energy Efficiency Alliance to review compliance and quality of energy codes in the state. Results have not yet been put into a final report format. A study on compliance in Oregon was conducted in 2008, as well, by the Northwest Energy Efficiency Alliance (NEEA) and was based on the code enforced in 2001. At the time, compliance was measured at 93%. The Oregon Building Codes Division Enforcement Program works with local jurisdictions to emphasize proper compliance. All jurisdictions are required to perform plan review, inspections and enforcement – without the ability to amend the state promulgated codes. BCD provides guidance and statewide interpretations to ensure consistent enforcement of the code throughout the state. All Building Officials are required to be certified by the State and complete 16 hours of continuing education every three years. A variety of training formats and venues are made available directly through BCD and others through partners such as the Oregon Building Officials Association (OBOA) and Oregon Homebuilders Association (OHBA). In addition, NEEA has developed and is presenting a modified version of the BCD energy code training.	2
Pennsylvania	There are no recent studies that have attempted to measure compliance rates in Pennsylvania. Enforcement is done by certified individuals who are either state employees, municipal employees or who work for certified third-party agencies that have been retained by municipalities. Code officials receive training in anticipation of passing the exams required to obtain initial certification and must engage in continuing education.	1
Rhode Island	Rhode Island is in the process of doing a baseline compliance study for the state with National Grid. Enforcement is done by the code officials in local jurisdictions, while the State Building Commissioner enforces the code for all state buildings. The RI Department of Administration has recently set up a schedule for mandatory training for building officials.	1
South Carolina	We currently have no information on compliance rates in South Carolina.	0
South Dakota	In pursuance of ARRA requirements, the state completed a report that lists recommendations for maximum compliance. Additionally, a December 2010 gap analysis was completed to analyze code adoption and recommend actions to achieve higher compliance. However, no studies measure compliance rates in the state. Enforcement is done at the local level. The Office of the State Engineer does contractually require building energy code compliance for state owned building projects. State government is not involved in training of local code officials or builders.	0
Tennessee	No studies have been completed to measure compliance rates in the state. The Tennessee Department of Commerce and Insurance has the authority to enforce residential energy codes and has conducted training for staff and local governments. Energy Codes Training and Enforcement programs are underway at the Tennessee Codes Enforcement Academy and the Department of Commerce and Insurance is in the process of establishing an on-line code training website, which will include energy code compliance. The Department has provided over 1,400 hours of IECC training for 235 code officials and is also initiating a web-based "Codes College" to provide computer-based codes training, particularly energy codes training, to officials and homebuilders.	1
Texas	In 2011, Texas BCAP released a study on compliance in the state that found uneven performance and presented a range of ideas to improve compliance. Texas is a home rule state, so enforcement is done by local jurisdictions. Local jurisdictions also decide the code compliance training requirements for their code officials. SECO is in charge of code compliance for state-owned buildings.	0.5

State	Summary of State Building Code Compliance Efforts	Score
	Builders are not required to take training since the Texas Residential Commission was dismantled. City building officials have to keep their certifications by CEUs, but it is not mandated by the state.	
Utah	Utah participated in a compliance pilot study in 2011 using PNNL methodology that showed, with limited numbers), compliance above 80% for residential and commercial buildings (both new and renovated). Local jurisdictions are obligated to enforce the adopted state codes. The Utah State Energy Program has been conducting energy code education since 2007. The free trainings have been made available across the state in more than 40 half- or full-day sessions. The free trainings were scheduled to continue in 2010 with an additional 8 full-day sessions, 7 hour-long webinars, and up to 4 special presentations for industry association meetings. The Office of Energy Development continues to provide training through Utah utility DSM funding. Additionally, grant funds from DOE/PNNL have allowed for increased training and personnel in 2011. The governor's 2011 energy plan includes increased energy code education as a way to raise public awareness and to treat energy efficiency as a resource. Lastly, the Utah Building Energy Efficiency Strategies Partnership (UBEES), an ARRA funded program, established a monthly "Code Compliance Capitol Morningsides Trainings". These two hour trainings are available as a webcast or in person and have received numerous Energy Star awards.	2
Vermont	There are no current studies that have attempted to measure compliance rates in Vermont, but one is expected to be released in January 2012. New construction is required to be code compliance, but the compliance with the residential code is not required to be filed anywhere while compliance with the commercial codes is required to be affixed to the heating system and filed with the Department of Public Service. The Department of Public Service provides training to builders in conjunction with the Department of Public Safety. There are no code officials and there is no standard training.	1
Virginia	A statewide building compliance study is scheduled to be completed by June 2012. Enforcement is done by local building departments. The Department of Housing and Community Development conducts 3 days of code training every three years for the new codes and any changes. Local seminars occur more frequently. Each technical assistant goes through 3 days of training for each certification they hold and all must take 16 hours of continuing education every two years.	1.5
Washington	The last study measuring compliance in Washington was conducted in 2008 by the Northwest Energy Efficiency Alliance and was based on the code enforced in 2001, which was based on ASHRAE 90.1-1999. At the time, compliance was measured at 94%. Enforcement is done through local jurisdictions. Training is up to local jurisdictions, where local trade associations and code chapters provide training for their members. Typically energy code trainings are contracted to Washington State University and the Northwest Energy Efficiency Council for instructors, and the Washington Association of Building Officials (WABO) offers some training sessions each year.	2
West Virginia	There are no current studies that have attempted to measure compliance rates in West Virginia. Enforcement is done by local planning offices throughout West Virginia. The WV Division of Energy has historically provided the only energy code training in the state.	1
Wisconsin	There are currently no studies that have attempted to measure compliance rates in WI due mostly to statewide requirements for inspection of all new buildings. However, the state did receive funding from the Department of Energy to implement a pilot study of compliance in commercial buildings; this study is not yet completed. All licensed UDC and WI Commercial Building Inspectors are required to obtain continuing education credits in order to renew their license. Each late winter/early spring, the 4 inspector associations put on training, but it is not mandatory. The Department of Commerce offers various training courses throughout the year, which are also not mandatory. Some courses are available online, others are addressed by organizations such as WI Focus on Energy, Energy Center of WI, WI Builders Association and others.	1.5

State	Summary of State Building Code Compliance Efforts	Score
Wyoming	There are no current studies that have attempted to measure compliance rates in Wyoming. Local jurisdictions that are established as local enforcement may, but are not required to, enforce energy codes at the local level. As a result of a partnership between the State Energy Office (SEO) and the Wyoming Conference of Building Officials, a 2009 Energy Codes Fundamentals course was held around the state. The SEO contracted with ICC to conduct those trainings. As a follow-up the SEO requested ICC to customize two one-day courses focused toward the designer community and the contractor community. Those trainings were held in June of 2011.	0