A BLUEPRINT FOR ACTION

Policy Options to Reduce Maine's Contribution to Global Warming

NATIONAL ASSOCIATION OF STATE PIRGS
NATURAL RESOURCES COUNCIL OF MAINE

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The New England Climate Coalition is a coalition of more than 160 state and local environmental, public health, civic and religious organizations concerned about the drastic effects of global warming in the Northeast.

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Executive Summary

Maine could make major strides toward reducing its emissions of global warming gases over the next several decades by adopting a series of policy strategies to make the state more energy efficient and reduce the use of fossil fuels.

Adoption of the 14 policy strategies in this report would bring Maine significantly closer to meeting its short- and medium-term commitments under a 2001 agreement signed by the six New England governors and their peers in eastern Canada. In the process, the strategies would reduce the state's consumption of energy and position Maine to make the technological shifts necessary to achieve the long-term goal of reducing Maine's emissions of global warming gases to levels that do not have a harmful effect on the climate.

Global warming, caused by human-induced changes in the climate, is a major threat to Maine's future.

- Since the beginning of the Industrial Age, atmospheric concentrations of carbon dioxide – the leading global warming gas – have increased by 31 percent, a rate of increase unprecedented in the last 20,000 years. Global average temperatures increased by about 1° F during the 20th century, a greater rate of increase than any in the last 1,000 years.

- The effects of global warming are beginning to appear in Maine and worldwide. The average temperature in Lewiston has increased by 3.4° F in the past century. Precipitation has declined by 20 percent.

- Average temperatures in Maine are projected to increase by between 2° F and 8° F over the next century, accompanied by increased precipitation. The results of these changes could include higher sea levels, degraded air quality, increased heat-related deaths, and the loss of Maine's hardwood forest species.

Emissions of carbon dioxide – the leading global warming gas – are on the rise in Maine.

- Between 1990 and 2000, Maine's direct emissions of carbon dioxide from energy use (other than electricity) increased by approximately 13 percent.

- Based on adjusted regional energy use projections from the U.S. Energy Information Administration, Maine's direct (non-electric) emissions of carbon dioxide could increase by as much as 16 percent over the next two decades, with much of the increase taking place in the transportation sector. In addition, electric sector emissions in New England can be expected to increase by approximately 35 percent between 2000 and 2020 if the region's nuclear reactors close at the expiration of their operating licenses to protect the environment and public health and safety.

Maine could significantly reduce its contribution to global warming by adopting 14 policy strategies and encouraging other New England states to do the same.

The policies include:

1. Putting increasing numbers of hybrid-electric cars (and eventually zero-emitting cars such as hydrogen fuel-cell vehicles) on Maine's roads over the next two decades by finalizing and implementing the **state's clean cars requirement**.

2. Adopting California's forthcoming **limits on vehicle carbon dioxide emissions**.

3. Requiring the sale of **low-rolling resistance replacement tires** that improve vehicle efficiency without negatively affecting safety.

4. Establishing a **"feebate"** program to reward the purchase of more fuel-efficient vehicles.

5. Requiring automobile insurers to offer **pay-as-you-drive automobile insurance**, in which insurance rates are calculated by the mile, rewarding those who drive less, while potentially reducing accidents.

6. Adopting policies that would **reduce growth in vehicle miles traveled** by cars and light trucks on Maine's highways, such as measures to reduce sprawling development and encourage the use of transit and other transportation alternatives.

7. Adopting the latest **commercial and residential building energy codes** to improve the energy efficiency of new construction.

8. Adopting **appliance efficiency standards** for a series of residential and commercial products.

9. **Reducing energy use** by increasing funding for energy efficiency programs supported by electricity ratepayers and creating similar energy efficiency programs for natural gas and heating oil.

10. Bolstering Maine's **Renewable Portfolio Standard** to require 10 percent of the state's electricity to come from new, clean, renewable sources by 2010 and 20 percent by 2020.

11. Implementing a systems benefit charge to **support renewable power**.

12. Limiting emissions of carbon dioxide from electric power plants through adoption of strong **state and regional power-sector carbon caps**.

13. Reducing **government sector emissions** through "lead by example" measures, such as the purchase of renewable power, increased energy efficiency, and the purchase of more efficient vehicles for state fleets.

14. Creating a framework for future market-oriented and/or regulatory responses to global warming through a regional **global warming emission registry**.

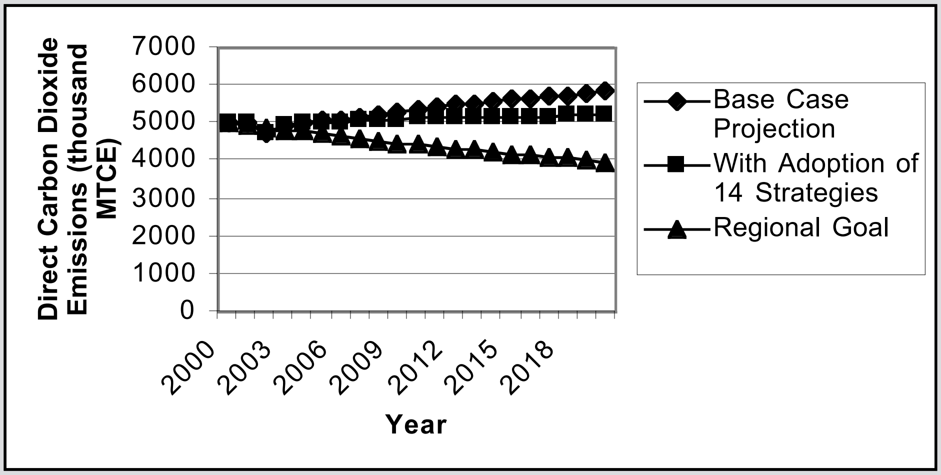
Adoption of all 14 strategies would achieve significant reductions in global warming emissions while improving Maine's energy efficiency and spurring the development of renewable sources of energy.

Table ES-1. Projected Annual Carbon Dioxide Emission Reductions from Proposed Policies (thousand metric tons carbon equivalent – MTCE)

Policy	2010	2020
Clean Cars Requirement	7.8	44
Carbon Dioxide Tailpipe Standards	13	160
Low-Rolling Resistance Tires	26	42
Feebate Program	15	67
Pay-As-You-Drive Automobile Insurance	43	47
Reduce Vehicle Miles Traveled	47	130
Residential and Commercial Building Codes	5.8-8.2	66-110
Appliance Efficiency Standards	34-73	97-210
Expanded Energy Efficiency Programs	160-240	370-550
Expanded Renewable Portfolio Standard	170-390	360-860
Renewable Energy Fund	0.28-0.66	1.1-2.7
State and Regional Electric-Sector Carbon Caps	***See high end of range of above estimates***	
Public Sector "Lead By Example" Policies	11-14	19-26
Regional Global Warming Emission Registry		***Not estimated***

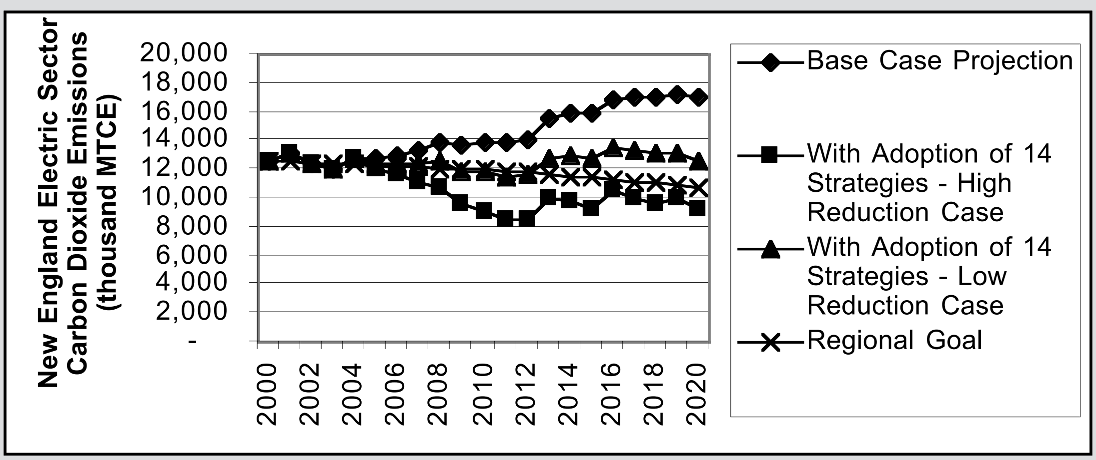
Note: Savings from individual policies do not equal cumulative savings due to some overlap between the policies.

Figure ES-1. Maine Direct Emissions of Carbon Dioxide (thousand MTCE)



- Adoption of these 14 strategies would reduce Maine's direct carbon dioxide emissions by about 11 percent below projected levels by 2020. (See Fig. ES-1.) Adoption of all strategies by all six New England states would reduce electric-sector emissions by as much as 45 percent below projected levels by 2020. (See Fig. ES-2.)

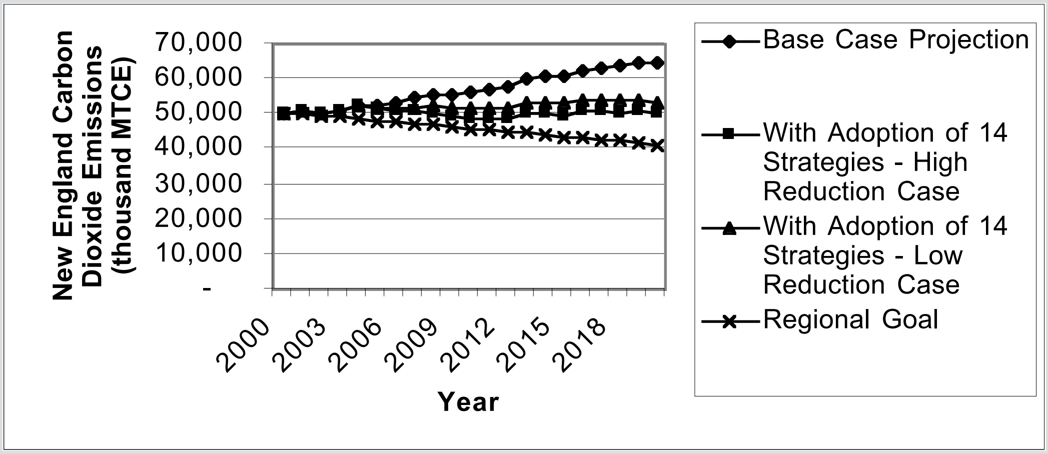
Figure ES-2. New England Electric Sector Carbon Dioxide Emissions (thousand MTCE)



Note: High Reduction case assumes strong state and regional electric-sector carbon caps. Low Reduction case assumes weak or no caps.

- New England-wide adoption of all 14 strategies would bring the region as much as 70 percent of the way to meeting the regional global warming emission reduction goal for 2010 and as much as 60 percent of the way to meeting the goal for 2020 – even with the retirement of several nuclear reactors that currently provide low-global warming emission electricity at high risk to the environment and public health. (See Fig. ES-3.)

Figure ES-3. New England Carbon Dioxide Emissions from All Sectors (thousand MTCE)



Note: High Reduction case assumes strong state and regional electric-sector carbon caps. Low Reduction case assumes weak or no caps.

- In addition, many of the strategies have benefits that extend beyond reducing global warming emissions, including reduction of emissions of other health-threatening pollutants, improvement of Maine's energy security, and retention of jobs and dollars in the local economy as opposed to the transfer of money out of state for fossil fuel purchases.

Maine should seize the opportunity to reduce its emissions of global warming gases.

- Maine should adopt the 14 measures in this report and investigate other policy options to reduce global warming emissions, especially with regard to reducing vehicle-miles traveled, limiting suburban sprawl, and encouraging the development of non-fossil, non-nuclear sources of energy.

- Maine should continue to participate in regional efforts to reduce global warming gas emissions, particularly the efforts of the Conference of New England Governors and Eastern Canadian Premiers and the northeastern states' negotiations to establish a regional, power-sector carbon cap.

- Maine should commit to achieving the governors' and premiers' long-term global warming emission reduction goal by 2050 and begin to plan for making the technological and other changes that will be needed to achieve that goal.

- Maine can and should reduce its global warming emissions without increasing the use of nuclear power.

Introduction

Global warming is a serious problem. The consensus view of climate science holds that global temperatures are increasing, that human activities are the cause, and that further warming of the planet is inevitable unless we significantly reduce our emissions of gases that trap heat in the earth's atmosphere.

The precise impacts that global warming will have on Maine are unknown, but it is virtually certain that the climatic shifts brought about by warming will leave the state's forests, rivers, coastlines and disease and weather patterns far different than we have known them – and so too, the Maine way of life.

While the effects of global warming are alarming, the solutions are not. We now know how to make appliances, automobiles, homes and buildings that use energy more efficiently, reducing global warming emissions from the combustion of fossil fuels. Renewable energy sources such as wind and solar power are becoming increasingly cost-competitive with traditional forms of energy. And highly advanced new technologies – such as fuel cells – show the potential to change the way we create and use energy in fundamental ways.

The path toward reducing the potential severity of global warming must begin with a resolve to do our share. In 2001, the governors of the six New England states and their peers in eastern Canada agreed to adopt a ground-breaking commitment to reduce the region's emissions of the gases that cause global warming. The success of that commitment, however, depends on the development and implementation of effective policies to reduce global warming emissions in each of the New England states, and eastern Canadian provinces.

This report presents 14 policy opportunities that if adopted would enable Maine to achieve most of the reductions in global warming emissions called for under the regional agreement. They are by no means the only steps Maine can or should take to reduce its contribution to global warming. But they represent a sound platform for future global warming efforts and move Maine significantly closer to the cleaner, more efficient, more sustainable and healthier future we all seek.

The opportunity for leadership exists. It is time for Maine to act.

Global Warming and Maine

Global warming poses a clear danger to Maine's future health, well-being and prosperity. Maine contributes to global warming primarily through the combustion of fossil fuels, which emit carbon dioxide to the atmosphere. Maine's emissions of carbon dioxide and other global warming gases have increased over the last decade and will likely continue to increase in the absence of concerted action.

Causes of Global Warming

Global warming is caused by the greenhouse effect – a natural phenomenon in which gases in the earth's atmosphere, including water vapor and carbon dioxide, trap heat from the sun near the planet's surface. The greenhouse effect is necessary for the survival of life; without it, temperatures on earth would be too cold for humans and other life forms to survive.

But human activities, particularly over the last century, have altered the composition of the atmosphere in ways that intensify the greenhouse effect by trapping more of the sun's heat near the earth's surface. Since 1750, for example, the concentration of carbon dioxide in the atmosphere has increased by 31 percent as a result of human activity. The current rate of increase in carbon dioxide concentrations is unprecedented in the last 20,000 years.[1] Concentrations of other global warming gases have increased as well. (See Fig. 1.)

As the composition of the atmosphere has changed, global temperatures have increased. Global average temperatures increased during the 20th century by about 1° F. In the context of the past 1,000 years, this amount of temperature change is unprecedented, with 1990 to 2000 being the warmest decade in the millennium.[3] Figure 2 shows temperature trends for the past 1,000 years with

Figure 1. Atmospheric Concentrations of Greenhouse Gases[2]

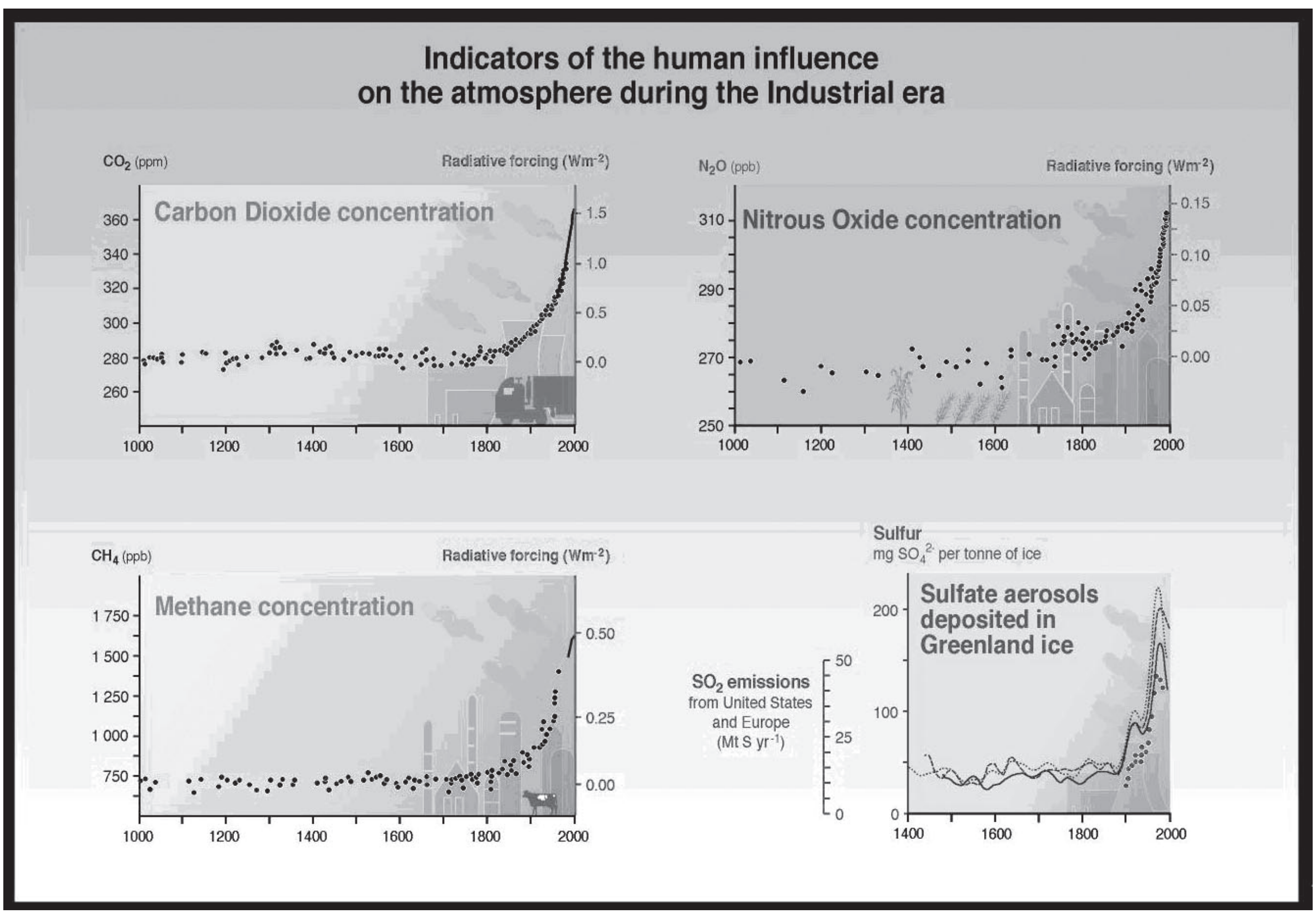
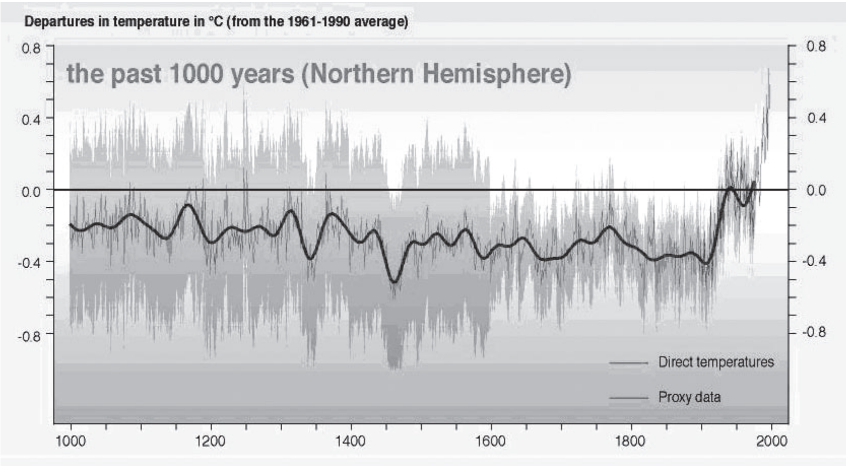


Figure 2. Northern Hemisphere Temperature Trends[5]



a relatively recent upward spike. Temperatures in the past 150 years have been measured; earlier temperatures are derived from proxy measures such as tree rings, corals, and ice cores.

This warming trend cannot be explained by natural variables – such as solar cycles or volcanic eruptions – but it does correspond to models of climate change based on human influence.[4]

Current Indications of Global Warming

The first signs of global warming are beginning to appear, both in Maine and around the world.

Other Global Warming Gases

Several gases other than carbon dioxide are capable of exacerbating the greenhouse effect that causes global warming. The other major global warming gases are:

- **Methane** – Methane gas escapes from garbage landfills, is released during the extraction of fossil fuels, and is emitted by livestock and some agricultural practices. It is the second-most important global warming gas in New England in terms of its potential to exacerbate the greenhouse effect.

- **Fluorocarbons** – Used in refrigeration and other products, many fluorocarbons are capable of inducing strong heat-trapping effects when they are released to the atmosphere. Because they are generally emitted in small quantities, however, they are estimated to be responsible for only about one percent of New England's contribution to global warming.[6]

- **Nitrous Oxide** – Nitrous oxide is released in automobile exhaust, through the use of nitrogen fertilizers, and from human and animal waste. Like fluorocarbons, nitrous oxide is a minor, yet significant, contributor to global warming.

- **Sulfur Hexafluoride –** Sulfur hexafluoride is mainly used as an insulator for electrical transmission and distribution equipment. It is an extremely powerful global warming gas, with more than 20,000 times the heat-trapping potential of carbon dioxide. However, it is released in only very small quantities and is responsible for only a very small share of New England's global warming emissions.

- **Black Carbon** – Black carbon, otherwise known as "soot," is a product of the burning of fossil fuels, particularly coal and diesel fuel. Recent research has suggested that, because black carbon absorbs sunlight in the atmosphere, it may be a major contributor to global warming, perhaps second in importance only to carbon dioxide. Research is continuing on the degree to which black carbon emissions contribute to global warming.

This report focuses mainly on emissions of carbon dioxide from energy use, since these emissions are responsible for the majority of Maine's contribution to global warming. Steps to reduce emissions of other global warming gases should also be part of the state's efforts to curb global climate change.

A Note on Units

There are several ways to communicate quantities of global warming emissions. In this report, we communicate emissions in terms of "carbon equivalent" – in other words, the amount of carbon that would be required to create a similar global warming effect. Other studies frequently communicate emissions in terms of "carbon dioxide equivalent." To translate the latter measure to carbon equivalent, one can simply multiply by 0.273.

Average temperatures have risen. Global average temperatures have increased by about 1° F in the past century. In the same period, the average temperature in Lewiston has increased by 3.4° F.[7]

Precipitation patterns have changed. Precipitation has decreased by 20 percent in many parts of Maine.[8] New Hampshire and Vermont have experienced a 15 percent decrease in snowfall since 1953.[9] Yet in some places in Massachusetts, precipitation has risen by 20 percent.[10] In other parts of the world, such as Asia and Africa, droughts have been more frequent and severe, a change that is consistent with models of climate change.[11]

Cold seasons have been shorter and extreme low temperatures less frequent. Since the late 1960s, Northern Hemisphere snow cover has decreased by 10 percent and the duration of ice cover on lakes and rivers has decreased by two weeks.[12] Glaciers around the world have been retreating.[13]

Oceans have risen as sea ice has melted. Average sea levels have risen 0.1 to 0.2 meters in the past century.[14]

Potential Impacts of Global Warming

The earth's climate system is extraordinarily complex, making the ultimate impacts of global warming in a particular location difficult to predict. There is little doubt, however, that global warming could lead to serious disruptions in the world's and Maine's economy, environment, and way of life.

Temperature increases in the past century have been modest compared to the increases projected for the next 100 years. Global temperatures could rise by an additional 2.5° F to 10.4° F over the period 1990 to 2100.[15] In Maine, temperatures could increase by 2° F to 8° F by 2100.[16] Others estimate that a 1.8° F increase in average temperature could occur New England-wide as soon as 2030, with a 6° F to 10° F increase over current average temperatures by 2100.[17]

Precipitation levels also could change. Maine could experience an increase in precipitation of 5 to 50 percent, with greater change in winter and less change in summer and fall.[18]

In any event, the impacts of such a shift in average temperature and precipitation would be severe. Among the potential impacts:

- Longer and more severe smog seasons as higher summer temperatures facilitate the formation of ground-level ozone, resulting in additional threats to respiratory health such as aggravated cases of asthma.[19]

- Increased spread of exotic pests and shifts in forest species – including the loss of hardwood forests responsible for Maine's vibrant fall foliage displays. This decline would be more than aesthetic: fall foliage-related tourism accounts for 20 to 25 percent of annual tourism in Vermont and Maine.[20]

- Decreased maple syrup production as winters become warmer or drier, reducing yields. Eventually, global warming may change the region's climate so dramatically that sugar maples no longer can survive in the region. This would be an economic blow: maple syrup production is a $20 million industry for New England.[21]

- Shifts in populations of fish, lobster, and other aquatic species due to changing water temperatures and changes in the composition of coastal estuaries and wetlands.[22]

- Increases in toxic algae blooms and "red tides," resulting in fish kills and contamination of shellfish.[23] This could threaten Maine's approximately $240 million shellfishing industry.[24]

- Declines in freshwater quality due to more severe storms, increased precipitation and intermittent drought, potentially leading to increases in water-borne disease.[25]

- Increased coastal flooding due to higher sea levels, with sea levels projected to rise as much as 14 inches near Rockland.[26]

- Increased spread of mosquito and tick-borne illnesses, such as Lyme disease, Eastern equine encephalitis, malaria and dengue fever.[27]

- Increased risk of heat-related illnesses and deaths.[28]

The likelihood and severity of these potential impacts is difficult to predict. But this much is certain: climate changes such as those predicted by the latest scientific research would have a dramatic, disruptive effect on Maine's environment, economy and public health – unless immediate action is taken to limit our emissions of greenhouse gases such as carbon dioxide.

Carbon Dioxide Emission Trends

The vast majority of carbon dioxide emissions in Maine result from the combustion of fossil fuels. Fossil fuels are burned directly in homes, businesses, vehicles and industrial facilities to produce heat, run our vehicles, and power machinery. Individuals and businesses also consume fossil fuels indirectly when they use electricity, much of which is created through the combustion of coal, oil and natural gas in power plants that provide power to Maine.

New England's economy is integrated across state lines, making it difficult in some cases to assign responsibility for carbon dioxide emissions to a particular state. For example, Maine draws its electricity from a New England-wide electric grid, which is supplied with power from across the region and beyond.

As a result, in this report we will consider emissions from energy end users and emissions from electricity generation differently. We will assess emissions from residential, commercial and industrial fuel combustion at the state level and emissions from electricity generators at the regional level.

Maine's Direct Emissions

Carbon dioxide emissions from sources other than electricity generation increased in Maine by approximately 13 percent from 1990 to 2000 – from 4,430 thousand metric tons carbon equivalent (thousand MTCE) to 5,020 thousand MTCE.[29] (See Table 1.) This estimate does not include emissions from the use of electricity in any of the sectors. While emissions in the residential, industrial and transportation sectors increased during the decade, commercial emissions declined.

In 2000, Maine's transportation sector was responsible for approximately 46 percent of its entire direct carbon dioxide emissions. The residential sector was responsible for about 21 percent of direct emissions, with the commercial sector responsible for 9 percent and the industrial sector for 24 percent. (See Fig. 3.)

The U.S. Energy Information Administration (EIA) has projected rates of increase in energy use in New England from 2000 to 2020. Applying the EIA's projected New England rates of energy use increases (with an adjustment to reduce what appears to be an overestimate of future increases in transportation gasoline use) to Maine, and applying standard fuel-specific emission factors to those estimates, Maine is projected to experience a 16 percent increase in all direct carbon dioxide emissions from energy use between 2000 and 2020 in the absence of mitigating action.[31] Between 2000 and 2010, emissions from these sources could increase by about 370 thousand MTCE, with a further 450 thousand MTCE increase between 2010 and 2020. Most of the

Table 1. Historic and Projected Maine Direct Carbon Dioxide Emissions (thousand MTCE)[30]

	1990	2000	*2010*	*2020*
Direct Emissions	4,430	5,020	*5,390*	*5,840*
Pct. Increase Over 1990		13%	*22%*	*32%*

increase in emissions is projected to take place in the transportation sector. (See Fig. 4.)

Regional Electric Sector Emissions

Carbon dioxide emissions from the electric power sector in New England increased by approximately 4 percent – or 600 thousand MTCE – between 1990 and 2000. (See Table 2.) The relatively modest rate of growth is due largely to the shift from higher-polluting coal and petroleum to less-polluting natural gas.

Between 1990 and 2000, Maine's electric sector emissions increased at the same rate as the region's. However, though Maine's electric sector carbon dioxide emissions rose by 4 percent, electricity production within the state declined by 12 percent, as a result of the safety-related retirement of Maine's Yankee nuclear power plant. Yankee produced 30 percent of electricity generated in Maine in 1990 but none in 2000. The electricity that had been generated by the nuclear plant was replaced primarily with power from natural gas-fired plants, which release global warming gases.[33]

Figure 3. Maine's 2000 Carbon Emissions by Sector (Excluding Electric Sector)

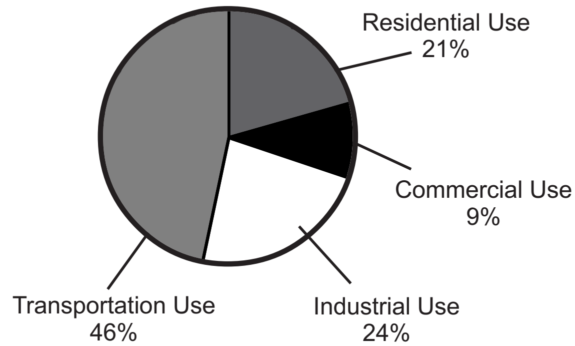


Figure 4. Maine's Direct Carbon Dioxide Emissions Are Projected to Increase 16 Percent From 2000 to 2020

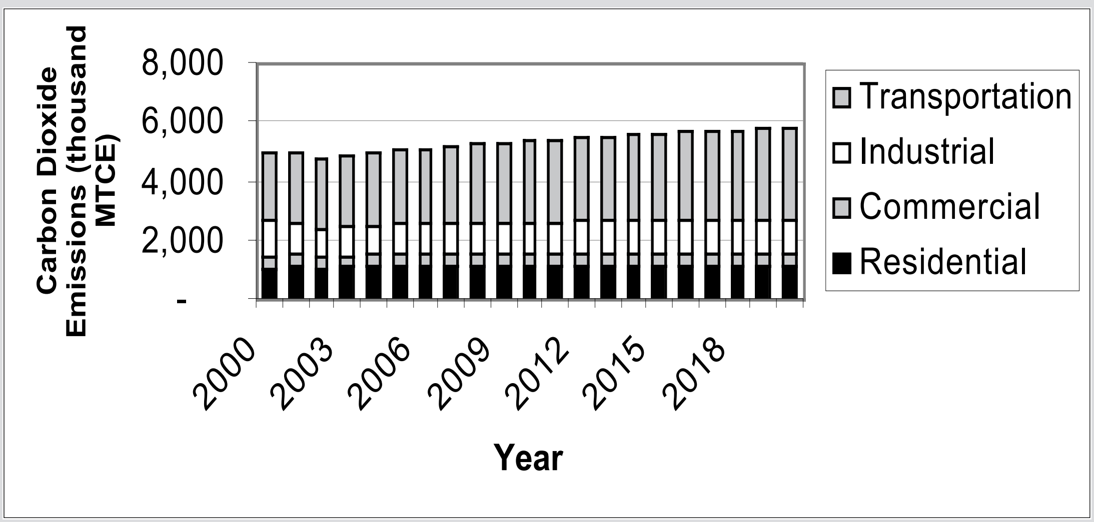


Table 2. Historic and Projected Electric Sector Carbon Dioxide Emissions in New England Without Nuclear Relicensing (thousand MTCE)[32]

	1990	2000	*2010*	*2020*
Electric Sector	12,000	12,600	*13,800*	*17,000*
Pct. Increase Over 1990	0%	5%	*15%*	*42%*

EIA's projections of future trends in energy use in New England assume the continued operation of three nuclear power plants whose operating licenses are scheduled to expire before 2020 (Connecticut's Millstone 2, Massachusetts' Pilgrim, and Vermont's Yankee). For environmental and public health reasons, the relicensing of existing nuclear plants or the construction of new plants is not an appropriate strategy to address global warming. (See "The Dangers of Nuclear Power," page 18.) Thus, in this report, we have adjusted the EIA projections to reflect the closure of nuclear plants as their licenses expire and their replacement with additional new natural gas-fired generation. This assumption results in significant increases in projected emissions of carbon dioxide versus EIA's projected trends.

Without the relicensing of nuclear reactors, carbon dioxide emissions from electricity generation in the region can be expected to increase by approximately 35 percent – or 4,400 thousand MTCE – between 2000 and 2020.[34] (See Fig. 5.)

Maine's current emissions trend will result in emissions far higher than those specified in the regional agreement. In order to meet the regional goal, Maine will need to cut its direct emissions of carbon dioxide by 22 percent below projected levels by 2010 and 47 percent by 2020. For indirect emissions, New England collectively will need to reduce its electric-sector emissions by 15 percent below projected levels by 2010 and 57 percent by 2020.

Regional and State Responses

The threat posed by global warming has provoked a variety of responses in Maine and the New England region. Despite a lack of leadership at the federal level – as evidenced by the U.S. government's unwillingness to support the Kyoto Protocol – regional organizations, governmental agencies, non-profits and some business groups have made efforts to craft solutions that would reduce New England's contribution to global warming.

New England/Eastern Canada Climate Change Action Plan

In September 2001, the governors of the six New England states, along with the premiers of the eastern Canadian provinces, adopted a regional Climate Change Action Plan that set specific goals for the reduction of global warming emissions in the region. The governors' and premiers' action was based on a history of international cooperation within the region to address environmental threats such as acid rain and mercury.

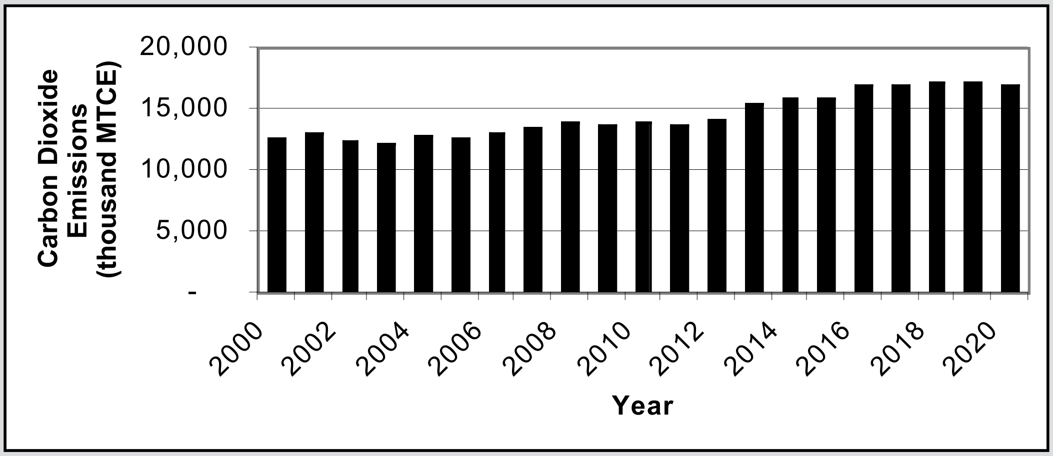
In the short term (by 2010), the plan calls for the reduction of global warming emissions in the region to 1990 levels. The medium-term goal, to be achieved by 2020, is to reduce emissions to 10 percent below 1990 levels. In the long run, now held to be 2050, the plan aims to

Table 3. Summary of Historic and Projected Carbon Dioxide Emissions and Regional Goal (thousand MTCE)

	1990	2000	2010	2020
MAINE DIRECT CARBON DIOXIDE EMISSIONS				
Historic/*Projected Emissions*	4,430	5,020	*5,390*	*5,840*
Regional Goal			4,430	3,980
Reductions Needed to Achieve Goal			962	1,860
Percent Reduction Needed to Achieve Goal			22%	47%
NEW ENGLAND ELECTRIC SECTOR EMISSIONS				
Historic/*Projected Emissions*	12,000	12,550	*13,820*	*16,980*
Regional Goal			12,000	10,800
Reductions Needed to Achieve Goal			1,820	6,180
Percent Reduction Needed to Achieve Goal			15%	57%

Note: The regional goals are the targets agreed upon by the New England Governors and Eastern Canadian Premiers in the 2001 regional accord to reduce carbon dioxide emissions. The governors and premiers agreed to reduce regional levels of carbon dioxide to 1990 levels by 2010 and to 10 percent below 1990 levels by 2020.

Figure 5. Projected (Base Case) Carbon Dioxide Emissions from Electric Generation in New England (thousand MTCE)[35]



achieve reductions of the degree needed to minimize dangerous threats to the climate. Scientists currently estimate that this will require reductions of 75 to 85 percent below current emissions levels.[42]

The agreement acknowledged that not every jurisdiction or every economic sector has the same potential to reduce its global warming emissions. However, in order to achieve the goals of the plan, it was envisioned that each state and sector of the economy would strive to make its share of the reductions.

The regional agreement also included a series of commitments for reductions in global warming emissions from conservation activities and from the transportation, electric and government sectors. Even if these sector-specific commitments are fulfilled, however, a 2003 New England Climate Coalition report estimated that the region's emissions of global warming gases will still exceed the goals of the Climate Change Action Plan.[43] (See Fig. 6, page 19.) To close the gap between the regional goals and the emission levels that would result from the sector-specific commitments, the Action Plan called upon states to develop their own plans and policies to reduce global warming emissions. Thus it is critical that Maine – and each state and province – adopt the strongest set of policies to reducing global warming pollution as possible.

The Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP) is continuing work toward implementation of the plan, focusing specifically on the development of an updated regional greenhouse gas inventory, the implementation of "lead by example" measures by state and provincial governments, and the investigation of measures to reduce transportation sector emissions and improve energy efficiency.

Maine Global Warming Gas Emission Reduction Efforts

The regional Climate Change Action plan also called upon each of the states to evaluate its current carbon dioxide emission levels and develop a plan for achieving required global warming emission reductions. Maine has taken several good steps directly targeting global warming and improving general energy efficiency.

In June 2003, the Legislature passed and Governor Baldacci signed a law requiring the state to develop a Climate Action Plan that will meet the same short-, medium- and long-term reduction goals as the regional action plan. To develop the plan, the Maine Department of Environmental Protection (DEP) has initiated a stakeholder process consisting of representatives from government agencies, business and industry interests, citizen groups, and environmental organizations. The DEP plans to submit its final action plan to the Legislature by October 2004.

The Dangers of Nuclear Power

For the last several decades, New England has relied upon nuclear power for a significant share of its electricity. However, between now and 2026 the operating licenses of all five of New England's operating nuclear reactors are scheduled to expire. For environmental and public health reasons, neither the relicensing of existing nuclear reactors beyond their original 40-year lifespans nor the construction of new nuclear facilities should be considered as a means to reduce global warming emissions.

- **Accident risk** – In the short history of nuclear power, the industry has experienced two major accidents – at Three Mile Island and Chernobyl – that endangered the health of millions of people. The Chernobyl accident alone contaminated an area stretching approximately 48,000 square miles, with a population of 7 million. Even today, 18 years after the accident, the region surrounding the reactor continues to suffer from highly elevated rates of thyroid and breast cancer and long-term damage to the environment and agriculture.[36]

  While the United States has thus far been spared an accident of the scale of Chernobyl, there have been numerous "near-misses." For example, in 2002, workers discovered a football-sized cavity in the reactor vessel head of the Davis-Besse nuclear reactor in Ohio. Left undetected, the problem could have eventually led to the leakage of coolant from around the reactor core.

- **Terrorism and sabotage** – The security record of nuclear power plants is far from reassuring. In tests at 11 nuclear reactors in 2000 and 2001, mock intruders were capable of disabling enough equipment to cause reactor damage at six plants.[37] A 2003 General Accounting Office report found significant weaknesses in the Nuclear Regulatory Commission's oversight of security at commercial nuclear reactors.[38]

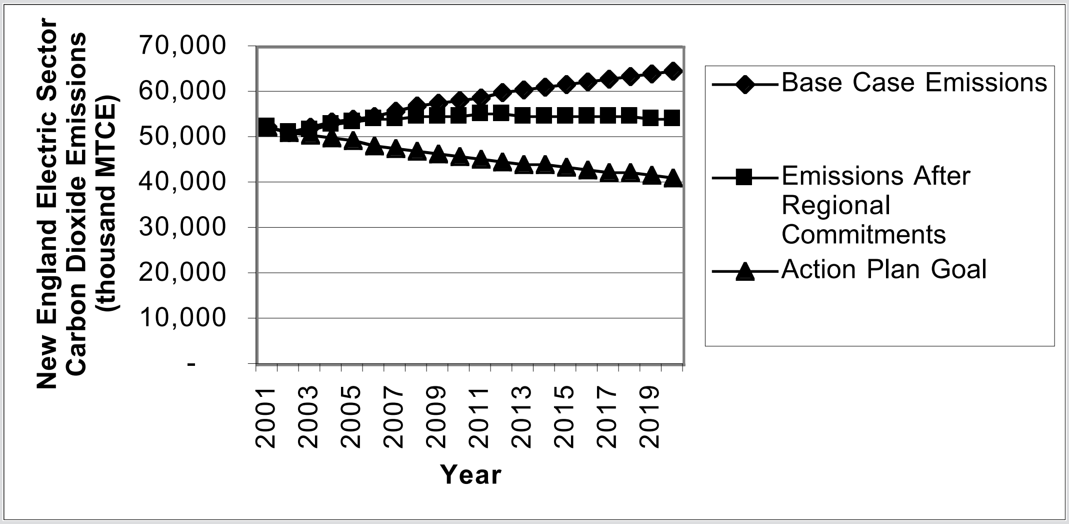
- **Spent Fuel** – Nuclear power production results in the creation of tons of spent fuel, which must be stored either on-site or in a centralized repository. Both options pose safety problems. Centralized waste repositories require the transport of high-level nuclear waste across highways and rail lines within proximity of populated areas. Once the waste arrives, it must be held safely for tens of thousands of years without contaminating the environment or the public. On-site storage poses its own problems. Nearly all U.S. nuclear reactors store waste onsite in water-filled pools at densities approaching those in reactor cores. Even Maine Yankee, which has been retired, still stores a significant amount of spent fuel. Should coolant from the spent-fuel pools be lost, the fuel could ignite, spreading highly radioactive compounds across a large area. The cost of such a disaster at a typical plant, were it to occur, has been estimated at 54,000-143,000 extra deaths from cancer, and evacuation costs of more than $100 billion.[39]

- **Cost** – Nuclear power has often proven to be expensive in market terms, due to the high cost of building, maintaining and decommissioning nuclear reactors. But looking only at market costs obscures the more than $100 billion spent by U.S. taxpayers for research and development, protection against liability from accidents, and other subsidies for nuclear power.[40] Without these subsidies, the nuclear industry likely could not have survived.

- **Aging** – Continued operation of nuclear reactors beyond their initial projected 40-year lifespan could lead to unforeseen safety problems. In 2001, the Union of Concerned Scientists identified eight instances in the previous 17 months where nuclear reactors were forced to shut down due to age-related equipment failures.[41] Maine has already faced this problem: numerous safety violations and the great expense of repairing an aging plant forced the closing of the Yankee nuclear reactor.

For these reasons and others, nuclear power should remain "off the table" as a potential means to reduce global warming emissions in New England, and the region should advocate for, and begin to plan for, the orderly retirement of New England's nuclear reactors.

Figure 6. Carbon Dioxide Emission Reductions in New England Under Implementation of Regional Climate Change Action Plan[44]



Though the action plan is still being developed, the state has already taken steps to reduce global warming emissions by the state government. In July 2003, the governor created an Office of Energy Independence and Security. The office's goals are to cut state government's energy costs, find energy savings throughout the state's economy, and develop the use of local energy sources, all of which will reduce global warming pollution. The state abolished its previous energy office almost 15 years ago, so part of the new office's work will be to coordinate the activities of the nine state agencies that do energy-related work.[45]

In November 2003, Governor Baldacci signed an executive order that will enforce the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) building standards for new and renovated state buildings. Maine is only the second state to adopt the high-efficiency LEED standards, which cover a wide range of building attributes, including optimal energy performance, water efficient landscaping, transportation options, use of local materials, and indoor air quality.[46]

Further, the state is purchasing 40 percent of its electricity from "reasonably priced" renewable energy sources, on its way to its pledge to purchase 50 percent.[47]

The state has also started using a blend of biodiesel with heating oil at Blaine House (the governor's mansion), and other state buildings. Biodiesel costs about 30 cents per gallon more than heating oil, but pure biodiesel emits 75 percent less carbon dioxide than petroleum diesel.[48] Also, it can be produced locally, from animal fat, vegetable oil, or even used cooking oil.[49]

New England Climate Coalition Action Principles

In 2001, in response to the development of the regional Climate Change Action Plan, a coalition of leading organizations from throughout New England worked together to articulate a set of principles to guide the region's efforts toward achieving reductions in global warming emissions. The New England Climate Coalition's 10 action principles have been endorsed by 160 environmental, public health, civic and religious organizations in the six New England states and Canada.

The principles are:

1) **By 2010, reduce greenhouse gas emissions to levels 10 percent below 1990 levels.** The international community has negotiated a treaty with binding commitments on most of the industrialized nations to reduce emissions to well below 1990 levels. The U.S. has failed to sign onto the treaty, but as the biggest emitter of heat-trapping gases, we must lead by reducing our emissions by at least the same percentage as the other largest polluters.

2) **The NEG/ECP's long-term goal of reducing greenhouse gas emissions by 75-85 percent should be given a target date of 2050.** This timetable is necessary to stem the increase of carbon dioxide (CO_2) concentrations and minimize global temperature variation.

3) **Each consuming sector should be responsible for at least its proportionate share of the targeted emission reductions.** Any changes to these responsibilities should be based on an explicit process, which justifies changes by the relative cost-effectiveness in each sector, and ensures that any shortfalls in one sector are offset by greater reductions in another. (The sectors to be included are transportation, industrial, commercial, institutional, and residential. This recognizes that the electricity sector targets will overlap.)

4) **The region and each of the states should establish a system of mandatory reporting of CO_2 and other greenhouse gas emissions by 2005.**

5) **Reduce emissions from the electricity sector as a whole by 40 percent from current levels.** Every plan should include provisions for reducing CO_2 emissions from grandfathered plants. Increasing the use or output of nuclear power is an unacceptable strategy for reducing electricity sector greenhouse gas emissions.

6) **The region and each of the states should set a target of 10 percent of electricity consumption from new, clean renewable sources by 2010, and 20 percent of electricity consumption from new, clean renewable sources by 2020.**

7) **Every plan should include a target of increasing energy efficiency in each sector by 20 percent by 2010.** The plans should consider more efficient generation of power, strong efficiency and conservation measures and greater use of combined heat and power and micropower options.

8) **The states should lead by example by:**
   a. Purchasing 20 percent of state facility electricity from clean, renewable sources by 2010.
   b. Greening the state fleet by establishing policies that require each vehicle purchased to be the model that emits the least CO_2 and other air pollutants per mile traveled, while fulfilling the intended state function; prohibit the use of inefficient vehicles such as SUVs for non-essential purposes; and establish a schedule for replacing all state vehicles with the most efficient models available.
   c. Reducing state government's energy use by 25 percent overall by 2010.

9) **Each plan should include long-term plans for controlling sprawl, which is one of the primary factors raising emissions from transportation and buildings.** At a minimum, this should start by incorporating an assessment of CO_2 impacts into the state environmental review processes.

10) **Each plan should recognize the economic development and job creation benefits of strategies to reduce greenhouse gas emissions.** And each plan should also recognize the importance of assisting displaced workers in making a successful transition to new employment.

The policy strategies that follow attempt to turn these principles into a concrete plan of action. In some cases, the policy strategies achieve results that go beyond those envisioned by the principles; in other cases, they fall short, and additional actions will be needed. But each of the strategies will help to propel the state toward achievement of its overall global warming emission reduction goals.

Reducing Emissions from the Transportation Sector

The transportation sector poses the greatest challenge for Maine as it seeks to reduce its emissions of global warming gases. Transportation is Maine's largest source of carbon dioxide emissions – responsible for about 46 percent of direct emissions in 2000. Transportation-sector carbon dioxide emissions could increase by an additional 35 percent between 2000 and 2020 if trends toward increasing vehicle travel continue.[50]

Light-duty vehicles are by far the largest source of transportation-sector carbon dioxide emissions, responsible for about two-thirds of transportation emissions in Maine.[51] Any strategy to deal with transportation's contribution to global warming, therefore, must begin with addressing emissions from cars, light trucks and SUVs.

There are three ways to reduce emissions from motor vehicles: improve fuel economy, switch to low-carbon fuels, or reduce vehicle travel. To achieve the kinds of reductions needed to meet Maine's commitments, the state will have to make progress in all three areas.

Strategy #1: Finalize and Implement the State's Clean Cars Requirement

Potential Savings: 7.8 thousand MTCE by 2010; 44 thousand MTCE by 2020.

The federal Clean Air Act allows states that fail to meet clean air health standards to choose between two sets of emission standards for automobiles: those in place at the federal level and the traditionally tougher standards adopted by the state of California.

In 1990, California established a new type of emission standard on vehicles sold in the state. In addition to meeting strict tailpipe standards (contained in the state's Low Emission Vehicle – or LEV – rules), a certain percentage of vehicles sold in the state would have to be "zero-emission vehicles" (ZEV). Over the decade-plus since the adoption of the ZEV standard, the rules governing the program have evolved to reflect changes in technology – primarily hybrid technology – and to increase the options available to automakers for meeting the requirement. The standards are scheduled to go into effect in California for the 2005 model year, and for the 2007 model year in most of the other states that have adopted California standards. The standards have been adopted, or are in the process of being adopted, by six other states, including every New England state except New Hampshire and Maine.[52]

Maine has already adopted other California's emission standards for automobiles, but has not chosen to implement the state's requirements for clean, advanced technology vehicles. Maine should adopt all of California's clean car rules, including the zero-emission vehicle program. Because the Clean Air Act requires states adopting California standards to give manufacturers two years of lead time prior to enforcement, Maine must adopt the new version of the program this year in order to begin implementation in 2007. Otherwise, the standards will be delayed, meaning that Maine will miss the opportunity to place thousands of cleaner vehicles on the state's highways.

While primarily a program for reducing smog-forming and toxic emissions from automobiles, the ZEV program's "technology forcing" component will likely reduce carbon dioxide emissions by requiring the introduction of significant numbers of "advanced-technology" vehicles (including hybrid-electric vehicles) and, beginning in 2012, hydrogen fuel cell vehicles. Beginning in 2006 (which is when 2007 model year cars will go on sale), automakers would be required to sell the equivalent of several thousand hybrid vehicles per year in Maine, with the numbers increasing over time. Then, beginning in 2012, automakers would be required to sell small numbers of hydrogen fuel-cell vehicles – again, with the numbers increasing over time. By 2020, about 12 percent of new light-duty vehicles sold in Maine would be hybrids, while about 3 percent would be hydrogen fuel-cell or other vehicles with zero emissions.[53]

In the near term, the ZEV program will place thousands of hybrid-electric vehicles on Maine's highways. Hybrids – such as the Toyota Prius and Honda Civic – use a small electric motor to complement the vehicle's gasoline engine. The electric motor allows the engine to be turned off at stop lights and helps to propel the vehicle. Hybrid systems also capture energy typically lost in braking and allow it to be used to help move the vehicle. The battery for the electric motor is recharged through normal vehicle use, so the vehicle never needs to be recharged from the electric grid.

Hybrid-electric vehicles have already proven popular with drivers in Maine and elsewhere. Hybrid-electric vehicle sales were expected to reach 40,000 in the U.S. in 2003 and are expected to exceed 177,000 by 2005.[54] The 2004 Toyota Prius was recently named *Motor Trend* magazine's "Car of the Year" and one of *Car and Driver*'s "10 Best Cars."

By setting targets for the sale of hybrid and other vehicles that are likely to emit less carbon than conventional vehicles, the ZEV program encourages automakers to introduce more models of clean cars, giving Maine residents broader choice of cleaner vehicles. In addition, the ZEV programs in Maine and other states will help automakers to achieve economies of scale in the production of hybrids, which would presumably be accompanied by a decrease in price. In the meantime, federal tax incentives (which are scheduled to be phased out over the next several years) and state taxes can help Maine consumers to afford hybrid vehicles, which typically cost about $3,000-$4,000 more upfront than similar models, but often save owners at least that much in fuel savings over the life of the car. The average costs of hybrids are about on par with the average cost of all vehicles sold in Maine.

The future of hydrogen fuel cell vehicles is less certain. Fuel cells use a chemical reaction involving hydrogen to produce electricity, which is then used to power a vehicle. When pure hydrogen is used in a fuel cell, the only byproducts are water and heat.

A limited number of fuel cell vehicles are currently on the road in demonstration projects. And while most major automakers have stated that they are committed to developing fuel cell vehicles, none has thus far committed to a firm timeline for widescale introduction. More vexing, significant technological and market hurdles remain in the way of an effective system for generating, storing and distributing pure hydrogen. Even if pure hydrogen can be used as a fuel, the possibility exists that polluting and dangerous fuels such as coal and nuclear power could be used to generate the hydrogen, creating new environmental and public health threats. Thus, renewable sources of hydrogen are central to a fuel cell future that delivers dramatic reductions in greenhouse gas emissions.

Despite these potential problems, fuel cells are inherently more efficient than traditional internal combustion engines and, ideally, could become an emission-free form of transportation for the future. Other technologies, such as battery-electric vehicles, are advancing as well, and could help fulfill the requirement for vehicles with no direct pollutant emissions, while natural gas and other clean alternative-fuel vehicles could also be used to meet program requirements. Much as the original ZEV program in California sparked research into electric vehicles that eventually led to today's hybrids, so too will the technology-forcing aspects of the current ZEV program hasten the development of the next generation of automotive technologies.

In its Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) model, the Argonne National Laboratory estimates that hybrid-electric passenger cars release approximately 47 percent less carbon dioxide per mile than conventional vehicles. Fuel-cell passenger cars operating on hydrogen derived from natural gas are projected to produce about 62 percent less carbon dioxide than conventional vehicles.[55] Assuming the level of emissions in the GREET model, and that manufacturers comply with the ZEV program in a similar way as the California Air Resources Board expects them to comply in California, Maine could anticipate about a 3 percent reduction in carbon dioxide emissions from light-duty vehicles by 2020 as a result of adopting the ZEV program.[56]

Strategy #2: Adopt California's Limits on Vehicle Carbon Dioxide Emissions

Potential Savings (Including Savings from ZEV Program): 13 thousand MTCE by 2010, 160 thousand MTCE by 2020 (estimated).

In 2002, California built upon its long history of pioneering efforts to clean up automobiles by enacting a law directing the state to set standards for carbon dioxide emissions from motor vehicles. The so-called Pavley Law (named after the sponsor, Assemblywoman Fran

Pavley) was the first policy in the nation to regulate carbon dioxide from automobiles.

Under the law, the California Air Resources Board is to propose limits that "achieve the maximum feasible and cost effective reduction of greenhouse gas emissions from motor vehicles." Limits on vehicle travel, new gasoline or vehicle taxes, or limitations on ownership of SUVs or other light trucks cannot be imposed to attain the new standards.[57] The new standards are to be proposed in 2005 and go into effect in 2009.

The carbon dioxide emissions standard adopted by the California Air Resources Board (CARB) pursuant to the Pavley Law would be part of the package of automobile emissions regulated by CARB. Other states that have opted into the LEV standards would have the ability to adopt the Pavley requirements. In addition to California, the Northeast states of New York, New Jersey, Massachusetts, Connecticut, Rhode Island, and Vermont have adopted California's other standards for low- and zero-emission vehicles and therefore will likely incorporate the new carbon dioxide emissions standards. Maine should adopt these standards, too.

Assuming that the Pavley Law is implemented, one must also make assumptions about the level of carbon dioxide emission reductions that will result from the program, since regulations implementing the law have not yet been developed.

In estimating the benefits of the Pavley standards, we assume that the regulations will require a 30 percent reduction in average per-mile carbon dioxide emissions for both new cars and new light trucks, phased in over a 10-year period. This estimate is significantly more conservative than California's initial proposed reductions in global warming emissions from automobiles under the Pavley law. CARB has proposed requiring reductions of approximately 30 percent in vehicle global warming emissions, but phased in more aggressively over a six-year period. Should this proposal be adopted, emission reductions under Pavley would be significantly greater than are projected here.[58]

Maine can lay the groundwork for implementation of the Pavley standards by incorporating them into its final Climate Action Plan, and by moving forward with full adoption of the latest ZEV program rules. The state should also encourage other New England and northeastern states to adopt the strongest available automobile emission standards. The emergence of a regional bloc of states in support of carbon dioxide emission standards will not only allow those states to monitor the California process as it is taking place, but will also create leverage that can be used in securing stronger market and economic strategies to reduce automotive carbon emissions at the federal level.

Strategy #3: Set Standards Requiring Low-Rolling Resistance Replacement Tires

Potential Savings: 26 thousand MTCE by 2010; 42 thousand MTCE by 2020.

Automobile manufacturers typically include low-rolling resistance (LRR) tires on their new vehicles in order to meet federal corporate average fuel economy (CAFE) standards. However, LRR tires are generally not available to consumers as replacements when original tires have worn out. As a result, vehicles with replacement tires often achieve lower fuel economy compared to vehicles with original tires.

The potential savings in fuel – and carbon dioxide emissions – are significant. A 2003 report conducted for the California Energy Commission found that LRR tires would improve the fuel economy of vehicles operating on replacement tires by about 3 percent, with the average driver replacing the tires on their vehicles when the vehicles reach four, seven, and 11 years of age. The report found that the resulting fuel savings would pay off the additional cost of the tires in about one year without compromising safety or tire longevity.[59]

Several potential approaches exist to encouraging the sale and use of LRR tires – ranging from labeling campaigns (similar to the Energy Star program) to mandatory fuel efficiency standards for all light-duty tires sold in the state. A standards program that required the sale of LRR tires beginning in 2005 in Maine – assuming the same tire replacement schedule and per-vehicle emission reductions found in the California study – would ultimately reduce carbon dioxide emissions from the light-duty fleet by about 1.6 percent by 2010 and 2.3

percent by 2020, while also providing a net financial benefit to consumers through reduced gasoline costs.

Strategy #4: Implement a "Feebate" Program

Potential Savings: 15 thousand MTCE by 2010; 67 thousand MTCE by 2020.

Fuel economy issues in the U.S. are solely managed by the federal government. This "federal preemption" limits the number of policy tools that are available to states to reduce the fuel consumption – and resulting carbon dioxide emissions – of passenger vehicles. One potential tool to reduce the global warming impact of motor vehicles is a package of fees and rebates based on carbon dioxide emissions, commonly known as a "feebate."

A feebate program would give financial incentives to car buyers who purchase more efficient – and less carbon-intensive – vehicles, and fund those incentives through fees on purchasers of less efficient vehicles, making the program essentially revenue neutral. At a designated point on the fuel economy scale – known as the "zero point" – a vehicle would receive no rebate and pay no fee. The ideal zero point for a revenue neutral feebate program is usually thought to be the average fuel economy of all vehicles sold.

There are many potential variations of feebate programs. Feebates can apply equally across all vehicle classes, or can include separate "zero points" for cars and light trucks or for vehicle subclasses (e.g. subcompacts). Feebates can be structured to apply either to new vehicles or to both new and used vehicles. Feebate rates can be applied in a linear fashion – with rates increasing in direct proportion to carbon emissions – or be structured to specifically target vehicles in the middle of the efficiency spectrum. Finally, the rate of the feebate can vary, from a token charge to levels that generate maximum fees/rebates in the range of several thousand dollars.

While no state currently has a feebate program in place (Maryland briefly adopted a program, but it was not implemented due to a legal dispute with the federal government over a separate labeling provision), Rhode Island has engaged in detailed discussions of potential feebate scenarios as part of its Greenhouse Gas Stakeholder Process. Likewise, Connecticut endorsed a feebate program in its stakeholder process, and feebate legislation has been introduced in the Massachusetts Legislature for the last few years.

The impact of a feebate program depends largely on how it is structured, but it also depends on the number of vehicles covered by the program. A 1995 study by researchers at Lawrence Berkeley National Laboratory found that the majority of the improvement in fuel economy that would result from a feebate program would be generated by the response of manufacturers – not the response of individual consumers. The study concluded that manufacturers would make more fuel efficient vehicles to respond to the economic signals from a feebate program, but that manufacturers likely would not respond if a feebate were only adopted by a single state.[61]

A feebate program adopted solely in Maine could, therefore, have limited results. However, a regional program – implemented consistently across the New England

The Federal CAFE Preemption

The setting of federal corporate average fuel economy (CAFE) standards for cars and light trucks in 1975 was the most important policy move in U.S. history to improve the fuel economy of light-duty vehicles. As a result of CAFE standards, the miles-per-gallon fuel economy of cars and light trucks nearly doubled between the mid-1970s and the late 1980s.[60]

Unfortunately, CAFE standards have remained largely stagnant over the last decade; standards for cars have not increased since 1990. Moreover, the federal law that created the standards also bars states from adopting regulations that are "related to fuel economy standards." The language of the law explicitly bars states from imposing fuel economy requirements on vehicles, but the use of the phrase "related to" also casts legal shadows on other measures – from efficiency-based fees and incentives to limits on carbon dioxide emissions from vehicles – that could be construed by some as "related to" fuel economy standards.

With the federal government resisting further significant increases in CAFE standards, however, it may be up to states such as Maine to implement incentives aimed at encouraging the purchase of vehicles that produce less carbon dioxide.

states – would not only bring a greater likelihood of manufacturer response, but would also ease implementation of the program by reducing the possibility of escaping the feebate by purchasing or registering vehicles in neighboring states.

Based on analysis conducted for the California Energy Commission, a regionally adopted feebate program – applied linearly to all new vehicles and based on carbon emissions – would reduce average carbon dioxide emissions from new cars by approximately 8.2 percent by 2020 and from light trucks by 8.4 percent.[62] This estimate is far from certain, since the California study modeled the impact of a feebate significantly larger in dollar terms than that currently being discussed in the New England states and because California's new vehicle market is approximately three times the size of New England's. On the other hand, the CEC report is based on somewhat optimistic assumptions about baseline increases in fuel economy that would occur without a feebate. Assuming that the CEC's assumed percentage emission reductions held true for a feebate assessed in Maine, carbon dioxide emissions from the light-duty vehicle fleet would be about 3.3 percent lower in 2020 than projected.

Strategy #5: Implement Pay-As-You-Drive Automobile Insurance

Projected Savings: 43 thousand MTCE by 2010; 47 thousand MTCE by 2020.

In a perfect market, the rates individuals pay for insurance coverage would accurately reflect the risk they pose to themselves and others. Automobile insurers use a host of measures – including vehicle model, driving record, location and personal characteristics – to estimate the financial risk incurred by drivers.

One measure that is not frequently used with any accuracy is travel mileage. Common sense and academic research suggest that drivers who log more miles behind the wheel are more likely to get in an accident than those whose vehicles rarely leave the driveway.[63] Many insurers do provide low-mileage discounts to drivers, but these discounts are often small, and do not vary based on small variations in mileage. For example, a discount for vehicles that are driven less than 7,500 miles per year does little to encourage those who drive significantly more or less than 7,500 miles per year to alter their behavior. As a result, the system fails to effectively encourage drivers to reduce their risk by driving less.

Requiring automobile insurers to offer mileage-based insurance is just one of many potential policies that attempt to reallocate the upfront costs of driving. High initial cost barriers to vehicle ownership – such as insurance, registration fees and sales taxes – may reduce driving somewhat by denying vehicles to those who cannot afford these costs. But for the bulk of the population that can afford (or has little choice but to afford) to own a vehicle, these high initial costs serve as an incentive to maximize the vehicle's use. Per-mile charges operate in the opposite fashion, providing a powerful price signal for vehicle owners to minimize their driving and, in the process, minimize the costs they impose on society in air pollution, highway maintenance and accidents.

A pay-as-you-drive (PAYD) system of insurance in Maine might work this way: vehicle insurance could be split between those components in which risk is directly related to the ownership of a vehicle (comprehensive) and those in which risk is largely related to driving (collision, liability). The former could be charged to consumers on an annual basis, as is done currently. The latter types of insurance could be sold in chunks of mileage – for example, 5,000 miles – or be sold annually, with the adjustment of premiums based on actual mileage taking place at the end of the year. Of critical importance to the success of the system would be the creation of accurate, convenient methods of taking odometer readings and communicating them to the insurer.

A pay-as-you-drive system of insurance would have great benefits for Maine – not only for reducing global warming emissions but also for improving highway safety and reducing insurance claims. Because insurers would still be permitted to adjust their per-mile rates based on other risk factors, mileage-based insurance would add additional costs for the worst drivers, giving them a financial incentive to drive sparingly.

Most importantly, however, a mileage-based insurance system would reduce driving. Converting the average collision and liability insurance policies to a per-mile basis in Maine would lead to an average insurance charge of about 4 cents per mile.[64] (For reference, a driver buying gasoline at $2.00 per gallon for a car that gets 20 miles per gallon would pay 10 cents per mile for fuel.)

If 80 percent of collision and liability insurance were to be assessed by the mile, the impact on vehicle travel would be significant. Research conducted by the U.S. EPA and updated by the Victoria Transport Policy Institute suggests that a per-mile charge of this magnitude (about 3.2 cents per mile in Maine) would reduce vehicle-miles traveled by about 5.1 percent, with carbon dioxide emissions from light-duty vehicles declining by roughly the same amount.[65] Should one-half of Maine drivers be covered by the PAYD option, light-duty VMT – and, therefore, light-duty vehicle carbon dioxide emissions – could be reduced by 2.6 percent.

While many insurers remain resistant to the administrative changes that would be needed to implement mileage-based insurance, the concept is beginning to make inroads. The Progressive auto insurance company offered a pilot PAYD insurance system in Texas and other pilot programs are underway elsewhere. In 2003, the Oregon Legislature adopted legislation to provide a $100 per policy tax credit to insurers who offer PAYD options.[66]

Maine should choose to introduce the concept by requiring insurers to offer it as an alternative to traditional insurance. If the concept proves successful, the state (or insurers) could then require liability and collision rates to be expressed in cents-per-mile – thus maximizing the carbon dioxide emission reductions and other positive results of the policy.

Unlike other policies that use price signals to reduce vehicle travel (such as an increased gas tax), mileage-based insurance has inherent aspects that make it an appealing policy option – regardless of its impact on global warming emissions. It ties the cost of insurance more closely to the actual risk incurred by driving. As a result, it should be closely studied, and ultimately implemented, in Maine.

Strategy #6: Reduce Growth in Vehicle Miles Traveled

Potential savings: 47 thousand MTCE by 2010; 130 thousand MTCE by 2020.

The growth in vehicle-miles traveled (VMT) over the last several decades has its roots in many societal changes – the redistribution of people and jobs away from Portland, Lewiston/Auburn and other cities to the suburbs, the elimination of some public transit opportunities, low gasoline prices, the increased participation of women in the workforce, and residential and commercial suburban sprawl.

Reversing this trend will be difficult, but success would bring benefits not only in reducing global warming emissions but in easing traffic congestion, reducing public expenditures on highways, enhancing Maine's energy security, and reducing automotive emissions of other pollutants that damage public health. It would be a reasonable goal for Maine to seek to reduce the growth rate in vehicle-miles traveled – projected by the Maine Department of Transportation to be approximately 0.9 percent annually until 2020 – to the rate of population growth in the state, projected by the U.S. Census Bureau to be approximately 0.5 percent per year between 2005 and 2020.[67]

The impact on vehicle-miles traveled of both transit improvement and growth management policies has been well documented. A variety of studies have documented that doubling the residential density of a given neighborhood reduces per-capita VMT by approximately 20 to 38 percent. Increasing the density of transit service has also been shown to reduce VMT.[68]

Because such effects are dependent on the characteristics of the community and the type of proposed policy or project, it is difficult to estimate the impact of any one statewide smart growth or transit strategy. Regardless, by adopting a package of "smart growth," transit, and transportation demand management (TDM) policies, Maine could encourage long-term shifts in development patterns and transportation decisions that would reap benefits in reduced vehicle travel and global warming emissions.

Among the policies implemented in or considered by other states that could help achieve this goal are the following:

- Improving the geographic reach, quality and frequency of existing transit services, and offering fares and schedules that maximize the use of existing transit infrastructure.
- Strengthening current efforts to direct state investments in transportation and other infrastructure toward designated growth areas near existing population centers.

- Encouraging transit-oriented development near train stations to expand the range of services available to commuters without having to use their vehicles.

- Encouraging location-efficient mortgages that allow households living near transit services to borrow additional money because their reduced transportation expenses increase their disposable income.

- Providing additional incentives to employers who encourage telecommuting, establish car- and van-pool programs, provide transit subsidies, or otherwise promote transportation alternatives.

- Implementing congestion pricing on major highways (in which commuters traveling during congested periods pay a toll) thus reducing rush-hour traffic and encouraging alternatives to single-passenger automobile use.

- Expanding bikeway networks and bike lanes, employing "traffic calming" techniques in town center areas, requiring sidewalks in all new developments, and adopting other policies to improve the safety and appeal of walking and bicycling.

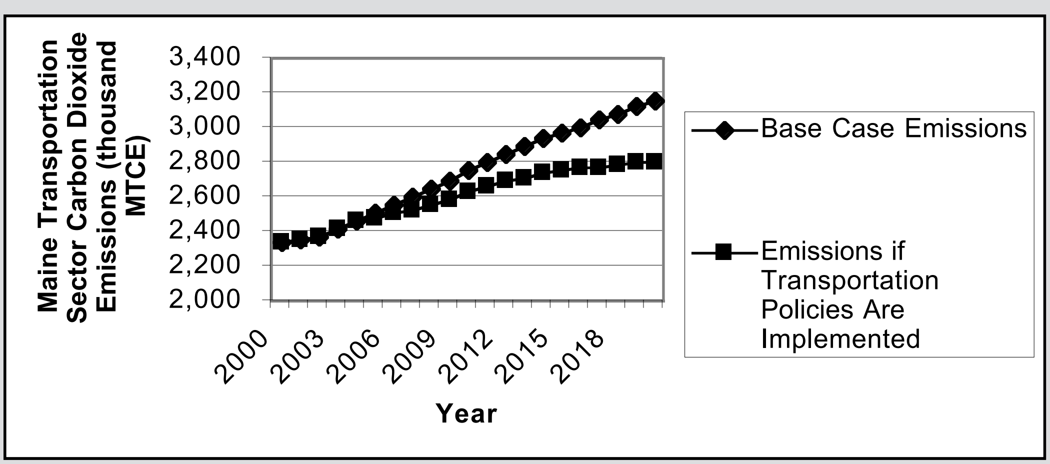
- Promoting "infill" development and redevelopment in existing urban and suburban areas through transfers of development rights, brownfields redevelopment incentives, urban development programs, and other means.

Regardless of the specific policies involved, Maine must realize that land use and transportation policies are integrally related, and should be aligned to achieve the same goals of reducing automobile dependence, reducing development pressure on the state's open spaces, and revitalizing urban areas. By adopting a state goal for the management of vehicle travel, and implementing that goal through a series of locally appropriate policies, Maine could go a long way toward meeting its global warming emission reduction goals.

Combined Impact of the Transportation Strategies

Implementing the six transportation strategies listed above would have a significant impact on Maine's transportation-sector carbon dioxide emissions by reducing vehicle-miles traveled and reducing the per-mile emissions of carbon dioxide from motor vehicles. Compared with a base case projection that assumes a 0.9 percent per year increase in VMT and no significant improvements in vehicle fuel economy, the actions listed above would reduce transportation sector emissions by about 120 thousand MTCE by 2010 and 350 thousand MTCE by 2020. At these levels, transportation-sector emissions in Maine in 2020 would be 470 thousand MTCE higher than 2000 levels and 550 thousand MTCE higher than 1990 levels (excluding savings from feebates).[69]

Figure 7. Projected Transportation Sector Carbon Dioxide Emissions (excluding savings from feebates)



Achieving even this level of emission reductions will require swift action. Many of the transportation-sector strategies (including feebates and the Pavley Program) have a long lead time before they begin to produce significant savings due to the fact that they primarily affect new vehicle purchases. In addition, the Pavley Program would not start until model year 2009 at the earliest. Once sold, new vehicles typically remain on the road for 10-15 years or more. Thus, any delay in adoption of these measures will result in more high-carbon vehicles traveling Maine's highways for years to come.

Finally, it is important to note the major role federal decision-makers can play in reducing carbon dioxide emissions from transportation. An increase in the federal corporate average fuel economy standard (otherwise known as the "CAFE standard") to 40 MPG, applied to both cars and light trucks and phased in over time, would have a dramatic impact on carbon dioxide emissions. Maine cannot afford to wait for Washington to take action on CAFE, but state officials should work with federal officials to promote a CAFE increase and other changes in federal transportation policy to reduce carbon dioxide emissions at the national level.

Additional Transportation Strategies to Consider

Some combination of other transportation-sector strategies will ultimately be necessary in Maine's efforts to reduce global warming emissions. Among them are the following:

- **Motor Fuel Taxes** – Taxes on gasoline and other motor fuels provide an incentive for individuals to reduce their driving and to purchase more efficient vehicles. Academic research shows that long-run fuel consumption is reduced by 3 to 10 percent for every 10 percent increase in fuel price.[70] While motor fuels tax increases have traditionally been unpopular with the public (and raise legitimate concerns with regard to the impact on low-income drivers), novel variations on the policy are possible. For example, the revenue generated by higher gasoline taxes could be used to reduce income or property taxes – thus preserving the tax increase's incentive for fuel conservation while making it revenue neutral in the aggregate. Alternatively, fuel tax increases could be dedicated to the expansion of transit services, incentives for the use of transportation alternatives, or incentives for the purchase of more fuel-efficient vehicles, in the same manner as systems benefit charges on electricity bills are used to support energy efficiency. However, Maine currently requires that all revenues from the gas tax be spent on roads and bridges. Maine should expand the use of gas tax funds to include transit and other transportation efficiency improvements.

- **Rail Improvements and Expansion** – Maine's network of operating and dormant rail corridors is a large potential resource for global warming emissions reduction. Rail can play two important roles: as a substitute for car and air travel (particularly for flights within the Northeast region) and as a substitute for air and highway freight delivery. Passenger rail operations release less than half the amount of carbon dioxide per passenger mile of air travel.[71] The 2001 resumption of passenger rail service on Amtrak's Downeaster train is a first step, but the frequency and speed of the trains needs to be increased and service must be made permanent. A connection in Boston between North and South stations would improve the usefulness of the Downeaster service for riders seeking to travel farther south than Boston. Maine should also move forward quickly with extending service to Freeport, Brunswick, Rockport, and Auburn. On the freight side, state officials should continue to consider modernization of the state's freight rail system, urge investments in interconnections with other regions, and improve intermodal connections. Rail improvements should receive a high priority for funding at the state level, as they will become an increasingly important component of Maine's transportation system over the next several decades.

- **Limits on Highway Expansion** – Congestion and safety problems on Maine's highway network are growing, sparking proposals to widen Route 1 to Camden, to create a bypass on Route 25 around Gorham, and to build the East-West highway. These proposed highway expansions would be costly – both in terms of the direct spending required of the state, and in terms of global warming emissions. Far from alleviating congestion, expansion of major highways has been shown in various studies to promote increased vehicle travel, leading to more fuel use, more global warming emissions, and eventually more traffic.[72] Rather than expand the state's highway capacity, transportation officials should adopt a policy that prioritizes roadway repairs and relies on transportation demand management strategies – such as car- and van-pooling incentives, road pricing, and expansion of transportation alternatives for both personal and freight travel – to meet the state's long-term transportation needs.

- **Limits on Diesel Pollution** – Diesel fuel – used predominantly in large trucks, buses, and other large vehicles and machinery – is a major source of both carbon dioxide and "black carbon," whose role in global warming some scientists believe may be very significant. Diesel vehicles also produce large amounts of particulates and other pollutants that endanger public health. Maine has several avenues open to it to reduce diesel emissions, including the adoption of standards for ultra-low sulfur diesel fuel, requirements for the retrofitting of existing diesel engines, the use of alternative fuels such as natural gas in public transit fleets, as is already beginning to be done by the Greater Portland Transit District and Portland METRO, and measures to reduce the amount of truck idling (such as the electrification of truck stops in the state and adoption of an anti-idling law).

Reducing Emissions from Homes, Business and Industry

The residential, commercial and industrial sectors are responsible for about half of Maine's direct emissions of carbon dioxide. There are, however, tremendous opportunities to improve the efficiency of energy use in all three sectors.

Strategy #7: Strengthen Residential and Commercial Building Energy Codes

Potential Savings: 5.8-8.2 thousand MTCE by 2010; 66-110 thousand MTCE by 2020.[73]

Building codes were originally intended to ensure the safety of new residential and commercial construction. In recent years, however, building codes have been used to reduce the amount of energy wasted in heating, cooling and the use of electrical equipment.

Maine first adopted voluntary energy standards in 1980. Some new residential and all new commercial construction became subject to minimum standards in 1989. Currently, residential construction in Maine is guided by the 1992 Model Energy Code (MEC). Due to exemptions in the law, however, only 5 percent of new residential construction is subject to the code. Commercial construction is guided by newer standards, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) code 90.1-2001. Enforcement of the codes, however, is weak.[74]

In 2004, the Maine Legislature updated the state's laws governing building and energy codes. As a result, it is likely that Maine will adopt the International Energy Conservation Code (IECC) as its standard. However, municipalities will have the option of not adopting any energy code.[75]

Model building energy codes are developed and updated at the national and international level. The International Code Council (ICC) is responsible for development of the International Energy Conservation Code (IECC), the most recent version of which was published in 2003.

A 2001 study by American Council for an Energy-Efficient Economy (ACEEE) estimated that homes meeting the 2000 IECC code would use approximately 15 percent less energy than homes not meeting the code, with a further 20 percent energy savings from the adoption of future codes that would go into effect after 2010.[76] The U.S. Department of Energy (U.S. DOE) estimates that the intensity of electricity use in New England commercial buildings would decline by approximately 10 percent if all states fully adopted the ASHRAE code 90.1-1999, versus the previous ASHRAE code.[77] ACEEE assumes a further 20 percent energy savings for all fuels in commercial buildings from future updates to the code.[78]

Based on the assumptions of ACEEE and U.S. DOE, the adoption of updated building energy codes would reduce residential oil and gas use by approximately 1.3 percent below base case projections by 2020. These estimates are likely conservative, since they attempt to quantify the impact of improved codes only on new construction. Applying codes to alterations and renovations to existing structures would result in even greater savings.

In estimating the carbon dioxide reductions that would result from improved building codes and other measures that reduce electricity use, a key factor is the type of electricity generation that is assumed to be affected by the reduction in consumption. Coal- and oil-fired power plants (particularly older plants) release significantly greater amounts of carbon dioxide per unit of electricity produced than modern natural gas-fired power plants. Thus, the resulting emission reductions are low if it is assumed that electricity savings reduce the need for the construction of new gas-fired power plants, and high if they reduce the amount of power coming from older coal- and oil-fired plants. In this report, where applicable, we present a range of emission reductions based on these different assumptions. It is likely that the higher emission reduction estimate would only be achieved under a strong state or regional cap on electric-sector emissions. (See Strategy #12.)

It is important to note that the success or failure of building energy codes depends largely on the degree to which they are enforced by local building officials in the state's cities and towns. With proper enforcement and training, upgraded building codes can ensure that Maine reaps the benefits of energy-efficient residential and commercial construction.

Strategy #8: Adopt Appliance Efficiency Standards

Potential Savings: 34-73 thousand MTCE by 2010; 97-210 thousand MTCE by 2020.

Household appliances and those used by businesses are a major source of energy demand. Since the first state appliance efficiency standards were adopted in the mid-1970s (followed by federal standards beginning in the late 1980s), the energy efficiency of many common appliances has been dramatically improved. For example, residential refrigerators complying with the latest national standards consume less than one-third the electricity annually of refrigerators manufactured in the early 1970s.[79]

The federal appliance standards program has led to great improvements in the efficiency of many appliances, but progress has slowed in recent years. Federal standards have failed to keep up with advances in efficiency technologies or have failed to take advantage of known efficiency opportunities. In addition, the federal program does not cover some appliances with great potential for improved efficiency.

States are pre-empted from adopting their own efficiency standards for products covered by federal standards, but there are two opportunities for states to take action. First, states may adopt efficiency standards for products not specifically covered by the federal program. In addition, states have the opportunity to apply for a waiver of federal pre-emption to apply stronger standards to products currently covered by federal standards.

An analysis conducted in 2002 by Northeast Energy Efficiency Partnerships (NEEP) assessed the potential energy savings that would result from the adoption of improved efficiency standards for 16 commercial and residential products.[80] (See Table 4.) Appliance efficiency standards are also a win-win for Maine's environment and economy. The NEEP study estimated that adoption of the package of appliance standards would bring Maine approximately $297 million in net economic benefit by 2020.[81]

Maine should move ahead with the adoption of efficiency standards for appliances not covered by federal rules, and apply for waivers of pre-emption for the others. In addition, the state should allow for the expedited adoption of future appliance standards for existing products and new products making their way into the marketplace.

Strategy #9: Expand Energy Efficiency Programs

Potential Savings: 160-240 thousand MTCE by 2010; 370-550 thousand MTCE by 2020.

One of the most promising opportunities for reducing carbon dioxide emissions in Maine is through improved energy efficiency. Stronger residential and commercial building codes and improved appliance efficiency standards, while important, are limited in their scope, leaving many existing buildings and sources of energy use untouched.

There are many barriers to the successful introduction of energy efficiency technologies. Potential users may not know about the technologies or have an accurate way of computing the relative costs and benefits of adopting them. Even when efficiency improvements are plainly justifiable in the long run, consumers may resist adopting technologies that cause an increase in the initial cost of purchasing a building or piece of equipment. In some cases, as with low-income individuals, consumers may not be able to afford the initial investment in energy efficiency, regardless of its long-term benefits.

Maine finances efficiency improvements through the assessment of a systems benefit charge (SBC) on consumers' electric bills. The concept behind the SBC is that all electric consumers share in the benefits when any consumer improves his or her energy efficiency. These benefits are both social (reduced global warming emissions and air pollution and improved long-run energy security) and purely economic (reduced need for expensive peak generation and ratepayer investments in transmission and distribution systems).

While nearly half of all states (including all six New England states) have adopted some form of SBC for electric utilities, fewer have implemented SBCs for natural gas, which is distributed through a regulated system similar to electricity. Similarly, the potential for SBC-type programs for other fuels – such as petroleum – has not been fully explored.

Maine established its system of SBCs through electric restructuring legislation adopted in 1997.[83] Mandatory SBCs are assessed in Maine to support energy efficiency programs and low-income assistance programs. We will discuss the voluntary SBC for renewable sources in more detail later in this report.

The efficiency SBC rate is capped at 1.5 mills ($0.0015) per kilowatt-hour, though some utilities charge less than the cap (the Public Utilities Commission sets the rates at a level to keep efficiency program funding consistent with pre-deregulation levels).[84] In total, the SBC generates approximately $15 million per year and will raise more as utilities raise their SBCs to the rate cap.[85] Only approximately half of this funding gathered each year through the SBC is available to pay for efficiency programs, as much of it is dedicated to previous commitments in the Power Partners Program made by utilities before deregulation.[86]

The Public Utilities Commission, through its Efficiency Maine Program, began offering trial energy efficiency measures in mid-2002. Results from a whole year of full operations are not yet available, but projections for 2004 are. The PUC projects that in 2004 its Efficiency Maine programs will spend $8.35 million to save approximately 25.5 GWh of electricity (a savings rate of about 3.05 kWh annually per dollar spent).[87] SBC funds support a wide variety of efficiency-related programs, including residential lighting replacement, municipal traffic signal upgrades, and loans for small businesses to purchase more efficient equipment.[88]

Should Maine increase its SBC for efficiency to 5 mills, the state could generate millions of additional dollars for efficiency improvements. Even assuming that efficiency savings from added SBC revenue would come at a substantially lower rate (given the decreasing availability of "low-hanging fruit" over time), Maine could still achieve significant carbon savings of 130-300 thousand MTCE by 2020.

The impact of a gas and oil SBC Program is more difficult to predict, but it would be sub-

Table 4. Products Covered Under Proposed Efficiency Standards[71]

Residential Products

Furnace fans

Torchiere light fixtures

Ceiling fans

Consumer electronics (standby power)

Central air conditioners and heat pumps

Commercial Products

Unit and duct heaters

Small packaged air conditioners and heat pumps

Beverage vending machines

Commercial refrigerators and freezers

Reach-in beverage merchandizers

Traffic signals

Exit signs

Commercial (coin-operated) clothes washers

Ice makers

Large packaged air conditioners

Dry type transformers

stantial. Based on Vermont's experience with a utility-based natural gas conservation program, the Connecticut Climate Change Stakeholder Dialogue estimated that the average first-year cost was $29 for 20-year efficiency measures that would save 1,000 cubic feet of natural gas annually.[89] (For comparison, the average natural-gas reliant household in Maine uses approximately 150,000 cubic feet per year.[90])

Maine already collects a small ($0.002 per gallon) federally authorized fee on heating oil which generates $800,000 annually that the Maine Oil Dealers' Association spends on efficiency programs.[91] Assuming that a broader gas and oil SBC-type program applied to residential, commercial and industrial consumption in Maine would achieve a savings rate of 75 percent of that experienced in Vermont, an SBC of 3.5 cents per 100,000 BTU would reduce Maine's carbon dioxide emissions by approximately 250 thousand MTCE by 2020 (which includes savings from the existing SBC-funded programs for natural gas). An SBC at this rate would translate into a rate of 3.5 cents per therm of natural gas, or 2.5 cents per gallon of distillate heating oil.

The near-term impacts of expanded residential, commercial and industrial energy efficiency programs may represent just the tip of the iceberg of the potential benefits of an expanded SBC program. By funding research and development into efficient new technologies and practices and broadening public understanding of the potential benefits of energy efficiency, these programs can create new opportunities for cost-effective energy savings in the years to come.

Combined Impact of the Residential, Commercial and Industrial Strategies

Adoption of the three strategies listed above would reduce carbon dioxide emissions from electricity use and direct combustion of fossil fuels in homes, businesses and industries by about 200-310 thousand MTCE in 2010 and 490-780 thousand MTCE in 2020. This estimate takes into account the fact that some equipment covered under proposed appliance standards could also be included in building codes by counting savings only from appliances not covered by codes.

Additional Residential, Commercial and Industrial Sector Strategies to Consider

A number of other strategies are available to reduce energy use in the residential, commercial and industrial sectors.

- **Green Building Certification** – State building energy codes provide the minimum design standards for energy efficiency in buildings, but even greater savings are available with good design and additional upfront investment. Commercial buildings certified to the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) standards achieve average energy savings of 25 to 30 percent beyond the ASHRAE 90.1-1999 commercial code. While LEED-certified buildings cost an average of 2 percent more to construct, they yield 20-year financial benefits of about 10 times the construction premium.[92] Maine has already adopted LEED standards for government buildings; it could do the same for all commercial construction. For residential buildings, Home Energy Rating Systems (HERS) can be used to measure code compliance or to set thresholds for a "green home" designation. In addition to enforcing LEED standards for new government construction, Maine should also identify ways to reward builders, businesses and home buyers who choose to certify their buildings to green building standards. Any program to promote green buildings should, however, also reinforce the state's smart growth goals. A "green" commercial building sited in such a way as to increase automobile travel may have a negligible – or even negative – net impact on global warming emissions. Likewise, Maine should give greater promotion to building smaller homes, with less environmental footprint.

- **Energy-Efficient Mortgages/Pay As You Save Programs** – Energy-efficient mortgages (EEMs) and pay-as-you-save (PAYS) programs are alternative models for financing the installation of energy-efficiency measures and distributed generation resources, primarily in the residential sector. EEM programs generally allow homebuyers to assume larger mortgages (sometimes on preferential terms) to finance energy efficiency improvements. PAYS programs allow consumers to pay for energy-efficient equipment or distributed generation resources (such as solar panels, small wind systems or fuel cells) over time on their utility bills rather than up-front. The charge remains on the utility bill until the equipment is paid off, regardless of who is living in the residence at the time. PAYS systems remove a major barrier from homeowners seeking to reduce energy demand: the prospect that they will not reside at the home long enough to enjoy the benefits of their investments. State officials should work with utilities and mortgage lenders to encourage and publicize EEMs and with utilities to experiment with pilot PAYS systems for efficiency and distributed generation.

- **Cluster and Mixed Use Development** – Smart growth policies are commonly thought to reduce global warming emissions by reducing the number of automobile trips required to carry out daily activities. But they may also have the secondary effect of reducing energy use within the buildings themselves. Many smart growth or "new urbanist" projects involve the renovation of existing buildings, construction of homes with less square footage than typical new suburban construction, or the combination of commercial and residential uses in a more space-efficient fashion. More research needs to be done to quantify the energy impacts of such projects, but Maine can spur their development by encouraging towns to develop zoning ordinances that allow, or provide incentives for, cluster and mixed-use developments.

- **Combined Heat and Power and Distributed Generation** – New and improved technologies now allow homeowners and businesses to generate their own power. Combined heat and power (CHP) systems allow commercial and industrial facilities to use waste heat from heating and cooling systems to generate electricity, or vice versa. CHP systems can vastly improve the efficiency of a facility's energy production and use. Because CHP systems generally rely on fossil fuels, they are less effective at reducing carbon dioxide emissions than renewable resources. Nonetheless, CHP should be encouraged, particularly for facilities for which renewable power does not make sense, by removing market barriers and easing interconnection with the electric grid. Similar incentives could promote the use of clean distributed generation (DG) technologies such as solar panels, small wind turbines, fuel cells, and small, high-efficiency turbines operating on natural gas or other low-carbon fuels. DG systems can reduce carbon dioxide emissions in two ways: by providing a lower-carbon source of electricity than power from the grid, and by providing that electricity closer to the point of use, reducing the amount of energy lost in transmission from a central power station to the end user. In addition to removing barriers to DG deployment, however, the state should adopt tight emission standards to ensure that distributed generators operating on fossil fuels or other dirty fuels do not contribute to local air pollution problems.

- **Solar-Ready Home Standards** – Maine should revise its building codes to require that new homes and commercial structures be built to allow the easy installation of solar photovoltaic systems.

Reducing Emissions from Electricity Generation

In addition to efforts to conserve electricity, Maine can also help to reduce carbon dioxide emissions from electricity use by working to make the New England electric grid cleaner – specifically by encouraging a shift away from carbon-intensive fuels such as coal and oil and toward renewable energy sources such as solar and wind. To achieve this goal, Maine must encourage the deployment of renewable energy sources while simultaneously adopting policies to reduce carbon dioxide emissions from fossil fuel generators through a state or regional electric-sector carbon cap. Regional cooperation on this matter is crucial, since current generation capacity and renewable resources are not distributed evenly across the six New England states.

Strategy #10: Enforce, Strengthen and Extend the Renewable Portfolio Standard

Potential Savings: 170-390 thousand MTCE by 2010; 360-860 thousand MTCE by 2020.

Maine is one of a number of states (along with Massachusetts and Connecticut) that have adopted a renewable portfolio standard (RPS) for electricity supplied to the state's customers. Essentially, an RPS requires that a certain portion of the power delivered by electric generators be derived from renewable energy sources. In many states, but not in Maine, the percentage of renewable power increases over time, providing a scheduled ramp-up to the provision of a significant portion of the state's power from renewable sources.

Maine adopted an RPS with the electric restructuring law of 1997, but it has several weaknesses. The program sets a goal of generating 30 percent of the state's power from renewable sources.[93] However, Maine already generates more electricity than this target from hydropower and other sources that do not contribute to global warming, so the new RPS does little to change Maine's energy mix.[94] Second, eligible sources include some that are not truly renewable and impose environmental damage.

Maine should amend its RPS to include standards that will increase the amount of new renewable power produced in the state, such as from wind power, and should exclude sources that emit greenhouse gases, or that cause severe environmental damage. A revised RPS should establish a target for *new* renewable generation that will increase the portion of the state's power that comes from renewable sources. An RPS that sets a target of 10 percent of the state's electricity from new, clean, zero-net-carbon renewables – with at least half of this coming from new wind power – by 2010, and 20 percent by 2020 is achievable and would result in a significant net reduction in carbon dioxide emissions from electricity generation.

Further, the list of eligible sources should be narrowed to include only truly renewable power. This would include wind, solar, and tidal power; low-impact hydropower that does not violate clean water standards or cause fish kills; and biomass facilities that burn only clean, renewable fuels such as wood and wood waste or that burn landfill gas that would be otherwise released to the atmosphere. Excluded would be sources such as fossil-fuel powered cogeneration, tire-derived fuels, and fuel cells powered directly or indirectly by non-renewable fuels.

One potentially important source of renewable energy for Maine is wind power. Wind power produces no global warming emissions or other air pollution. Unlike hydropower, which can harm the ecology of rivers, wind turbines cause relatively little environmental harm. Once a wind farm is constructed, operating costs are low because the fuel – wind – that powers the turbines is free. Maine, with hillsides and offshore breezes, has tremendous wind energy potential. Maine's first wind farm, the Mars Hill Wind Project, located in Northern Maine, was recently permitted by the State; construction is expected to start this fall.

With these targets, Maine would achieve savings of 170-390 thousand MTCE by 2010 and 360-860 thousand MTCE by 2020, with the higher near-term estimate based on adoption of a strong regional carbon cap that allows for reductions in electricity consumption to offset generation from coal-fired power plants. (See Strategy #12.)

Likewise, Maine should support the regional adoption of RPSs. Under a regional RPS with a goal of 10 percent new renewables by 2010 and 20 percent new renewables by 2020, applied to all power consumption in the region, the New England states would generate more than 11,000 GWh of power from new renewable sources by 2010, and 21,000 GWh by 2020, over and above the amount of renewables that would already be deployed under the existing RPSs in Massachusetts and Maine, and an older version of the RPS in Connecticut. Several forms of renewable energy could be used to meet the RPS requirement, including wind power, solar power, landfill gas, and perhaps new technologies such as run-of-the-river hydropower, if they are proven to be effective and environmentally benign.

Is such a level of renewable power production in New England feasible? The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) has calculated that New England has the potential to generate as much as 34,000 GWh per year using onshore wind resources alone.[95] This estimate does not include the wind energy that could be harnessed by offshore wind turbines, which could potentially supply more electricity each year in New England than the region currently consumes.[96] With continuing technological improvements which reduce the cost of wind power generation, much of this wind potential could be cost-effectively captured sooner than other sources.

In sum, fulfilling a 20 percent renewable portfolio standard for New England with wind alone would require the development of less than two-thirds of the region's onshore wind potential under even the most conservative estimates, and without factoring in the potential for technological improvements to make wind power feasible for distributed applications and at lower wind speeds. Allowing solar, landfill gas, and clean biomass (that which does not contribute to toxic air emissions) to fulfill the mix makes this task even more readily achievable. Massachusetts, for example, has already approved New England landfill gas projects with a nameplate capacity of about 50 MW to qualify for the state's RPS.[97]

Maine should strengthen its RPS and push other New England states to enact strong legislation of their own. Adoption of consistent standards across New England would be beneficial. First, the region should agree on a set of rules for inclusion under an RPS that emphasize truly clean, truly renewable technologies. Polluting and environmentally damaging technologies, along with those that rely on non-renewable resources, should be excluded from use to fulfill RPS requirements. In some cases, difficult decisions will have to be made to preserve the spirit of the RPS. For example, stationary fuel cells that run on natural gas, while they may be environmentally beneficial, should not receive credit under an RPS due to their ultimate reliance on fossil fuels. Other incentives should be used to promote technologies, such as fossil fuel-powered fuel cells, that improve efficiency but do not draw on truly renewable resources.

The need for regional standards is particularly important because any RPS is necessarily going to require the purchase of credits from new renewable generation in other states. States vary greatly in their potential for successful renewables development, so it is only fitting that states get credit for the role they play in facilitating the development of renewables in neighboring states. For example, Massachusetts' RPS allows the fulfillment of requirements through the development of renewables in other New England states, including Maine, or even outside the region.

Maine should commit to reaching the 10 percent goal for new renewables by 2010 (with half of this coming from wind power) and 20 percent by 2020. At the same time, the state should work with other New England states to support a similar, regional requirement, with tight and effective mechanisms for tracking, purchasing and trading renewable power certificates.

Strategy #11: Support the Development of Renewable Energy

Potential Savings: 0.28-0.66 thousand MTCE by 2010; 1.1-2.7 thousand MTCE by 2020.

Non-hydroelectric renewable energy sources play a small role in the generation of electricity in New England. Adopting a strong renewable portfolio standard as discussed above will increase the amount of wind and solar power supplying electricity to Maine's consumers through the power grid. But there is more the state can do.

The state can further promote the development and use of renewable power by implementing a systems benefit charge to support renewable power. Technological, financial, and market barriers, and lack of public awareness currently limit broad use of renewable power, especially of small-scale projects. SBC revenue can be used to support research and development of new renewable technologies and to hasten their deployment in the marketplace through rebates and education.

Maine currently has a small program to promote renewables. Customers of Maine's utilities can opt to make a voluntary contribution to the Renewable Resources Matching Fund. This has generated roughly $70,000 since the fund's inception. This funding allows the Maine Technology Institute (which administers the program) to subsidize up to half the cost of renewable energy demonstration projects and renewable energy research by several Maine institutions.[98]

A systems benefit charge of 1 mill per kWh on all kWh-based electricity sales in Maine would produce approximately $11 million annually.[99] With that, the state could create a Clean Energy Fund that could offer loans and rebates to help individual customers finance purchases of renewable generating installations; support research on renewable energy technologies; and provide public education about renewable energy's potential and availability.

Imagining a scenario in which a small portion of the increased funding is applied to promoting the installation of solar power demonstrates how significant this renewables SBC could be. Barring a technological breakthrough that lowers costs, solar power will likely remain a minor source of electricity for at least the next decade. But solar photovoltaics (PV) have the potential to make a major contribution to a clean energy future. Costs have already gone down by 75 percent over the past 20 years.[100] Investing in solar power today will reduce the ultimate cost of solar power by creating greater economies of scale within the industry.

A $4,000 per kW subsidy appears to be sufficient to make solar power cost-competitive in New England in the near term. A recent analysis found that a solar PV system for a commercial building in Maine (including the subsidy) could cost as much as $5,000 per kW and still break even financially for the purchaser. With a $4,000 per kW subsidy, this breakeven point would exceed $9,000 per kW. Installed commercial PV systems in the U.S. currently range in price from $7,000 to $12,000 per kW, which would make PV systems marginally cost-competitive in Maine with a subsidy.[101] In addition, a $4,000 per kW subsidy would be sufficient to push the residential breakeven cost of solar PV above $7,000 per kW, bringing residential solar to within the margins of competitiveness.[102]

A solar subsidy program of the kind described here, if funded at 0.15 mill/kWh, would result in the generation of about 4.7 GWh of power from new solar installations in Maine by 2010 and 19 GWh by 2020. A comparable 0.15 mill-funded program across the region would generate 47 GWh by 2010 and 189 GWh by 2020. Even with this ramp-up of solar power, less than one percent of New England's electricity would come from solar PV by 2020. And the new solar PV systems would not even begin to tap New England's potential for solar PV development, with the equivalent of only about 40,000 New England homes bearing rooftop solar PV systems by 2020.[103]

While a solar program such as the one envisioned here would have only a limited short- and medium-term impact on carbon dioxide emissions in New England, the long-term impact is potentially great. The increased installation of solar PV systems would improve the economics of solar power and begin to change the perception of solar systems from exotic curiosities to a day-to-day feature of life in many communities. With a long-term commitment to fund solar installations in Maine and throughout New England, manufacturers of PV systems would have a strong incentive to increase their production capacity, reducing costs. The state and region would then be poised for a dramatic increase in solar installations in the 2020-2050 period; precisely the time when the region will be needing to make deep reductions in its global warming emissions in keeping with the New England governors' long-term goal.

A systems benefit charge in Maine to support a Clean Energy Fund that promotes the development and installation of all types of renewable energy could provide a powerful boost to solar power, small-scale wind, and other renewables.

Strategy #12: Adopt a Strong Carbon Cap for Reducing Electric Sector Emissions

Potential Savings: Included as high end of range of estimates above.

Maine is currently working with nine other northeastern states, from New Hampshire to Delaware, to develop a regional cap-and-trade system for electric-sector global warming emissions. The initiative, known as the Regional Greenhouse Gas Initiative (RGGI), parallels similar efforts in both Massachusetts and New Hampshire as well as discussions of similar limits at the federal level.

The RGGI process provides an opportunity to shift from widespread reliance on polluting, carbon-intensive coal- and petroleum-fired generation and dangerous nuclear power to the increasing use of renewable power, energy efficiency, and other low- or zero-carbon forms of generation to meet the region's electricity needs.

However, the promise of these efforts could easily be lost if the level of the cap does not drive significant emission reductions. It could also lose public support if the program makes the dangerous tradeoff of allowing nuclear power to get credit, subsidies or broad market advantage as a source of "clean" power.

- **Cap Levels** – The program must establish a target for the total amount of carbon that can be released. This target should be significantly lower than current emissions.

  Opportunities for reducing emissions from the electric sector are numerous, including the promotion of energy efficiency in homes, businesses and industry; the retirement of old, inefficient fossil fuel-fired power plants; and the expansion of renewable and clean distributed generation.

  These initiatives are potentially mutually reinforcing. Reducing growth in electricity consumption reduces the amount of new generating capacity that must be built to satisfy demand. Renewable and distributed generation further reduces demand for fossil and nuclear generation. Together, these changes reduce the necessity to maintain existing, inefficient sources of generation and allow their expedited replacement with more efficient sources.

  The New England Climate Coalition, of which the Natural Resources Council of Maine is a member, recommends an overall goal of reducing carbon dioxide emissions from electricity generation by 40 percent below current levels. The adoption of aggressive efficiency and renewables programs by all six New England states would bring this goal within reach by 2020, with reductions of as much as 30 percent below current levels possible if energy efficiency improvements and new renewables are used to reduce generation of electricity from the highest carbon-emitting sources. (See box, page 38.)

- **Nuclear Power and Offsets** – A carbon cap-and-trade program should not be allowed to become a backdoor subsidy for nuclear power.

  For environmental and public safety reasons, Maine and the New England states should be moving toward a phase-out of nuclear generating capacity, beginning particularly with the retirement of existing nuclear reactors upon the expiration of their current operating licenses. Nuclear plants were not designed to operate for longer than their current licenses. The expansion or maintenance of nuclear generating capacity in New England or elsewhere should not be permitted to qualify as an offset under any cap-and-trade program.

  The use of offsets as a method of compliance with the carbon cap also produces other potential problems. Massachusetts' rule for its electric sector carbon dioxide emission cap requires that any offsets provide "real, surplus, verifiable, permanent and enforceable" emission reductions.[104] Practically speaking, designing offsets that meet these criteria is extraordinarily difficult. Demonstrating that an emission reduction is truly "surplus" requires administrators of a cap-and-trade program to assess what would have happened in the absence of a cap – for example, whether energy efficiency improvements used to generate offsets would have happened anyway. Assessing permanence requires frequent verification that previous emission reductions or sequestration activities remain in effect.

  A sure way to avoid these problems is to draw the boundaries of any trading program very narrowly – including only those sources that emit carbon dioxide, and only those within the region covered by the program (in the case of RGGI, within the 10-state region).

- **Leakage** – In theory, emission reductions that would be generated by a state or regional carbon cap could be offset by increased emissions resulting from power imported into Maine or the Northeast. To prevent this "leakage" of emission reductions, the region must ensure a level playing field between electricity generated in the Northeast and imported electricity, perhaps by setting carbon dioxide emission standards for imported electricity. Another alternative is to expand the cap to cover a broader geographic area, while maintaining strong provisions to ensure that the cap is enforced.

- **Auctioning Credits** – Another point of tension revolves around whether existing electricity generators in the Northeast would be required to buy emission credits at the outset of a carbon cap or be given them for free. The free granting of emission credits to existing generators would act as a *de facto* subsidy to those plants, as well as grant those plants an effective "right to pollute." In contrast, the auctioning of emissions credits could produce a source of income that could be returned to all residents, used to support efficiency and renewable power, or used for transition help for displaced workers.

The resolution to these issues will come through extensive negotiations over the coming months. Maine should use its position in the talks to maximize the potential benefits of the regional carbon cap, and preserve its options to cap electric-sector emissions through other channels, such as through a New England-wide or state program.

Other Electric Sector Strategies to Consider

- **Green Power Option** – The advent of retail competition in electricity markets was to have brought Maine residents and businesses a variety of choices for electricity supply – including the choice to purchase power generated from renewable and more benign resources. Several companies in Maine – including the Green Power Connection – offer consumers electricity from sources such as these. In addition, the Legislature has granted the Public Utilities Commission the authority to offer a "green standard offer" to all Maine electricity consumers as their default service if they do not choose a different power product.

Like the transportation sector, the electric sector is a major source of global warming pollution in New England. Unlike the transportation sector, however, Maine and other New England states have a number of effective policy tools available to both improve energy efficiency and facilitate the shift to lower carbon sources of energy in the electricity sector. As a result, the potential for savings in the electric sector is disproportionately large and the state and region should take full advantage of that potential.

Public Sector and Other Strategies

Strategy #13: Public Sector "Lead by Example"

Potential Savings: 11-14 thousand MTCE by 2010; 19-26 thousand MTCE by 2020.

Federal, state, and local governments are significant users of energy in Maine. State government alone consumes about 1.1 percent of the state's electricity, along with large amounts of natural gas, heating oil and motor fuel.[106] But reducing energy use in the government sector not only has a direct impact on global warming emissions; it also sets an example for the private sector as to what can be achieved.

The state of Maine has already adopted some policies and practices that improve energy efficiency within state government and thus reduce the government's contribution to global warming. These policies include buying renewable power for state use, implementing stricter building codes for state buildings, buying fuel efficient cars, and establishing concrete goals for reducing energy use by state government.

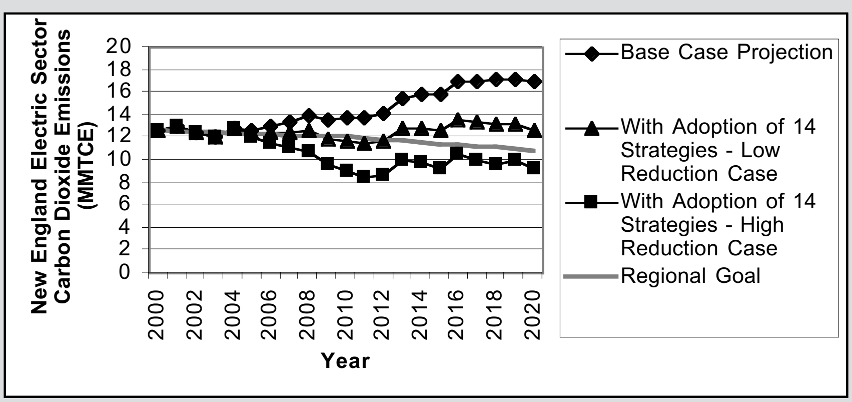
To set an example for the private sector and to meet its own emission-reduction goals, the state should:

The Role of a Regional Carbon Cap in Reducing Electric-Sector Emissions

To demonstrate the feasibility of a strong electric sector carbon cap without nuclear relicensing, estimates were made of current and projected New England electricity use and carbon emissions based on the adoption by all six New England states of the policies described in this report.

Were a carbon cap to be structured so as to use efficiency savings and new renewables from the policy measures in this report to offset generation first from coal-fired power plants, then oil-fired plants, New England could achieve up to a 29 percent reduction in electric sector carbon dioxide emissions by 2020 versus baseline 2001 levels. (See "High Reduction Case" in Fig. 8.) By contrast, using those efficiency savings and new renewables to offset natural gas-powered generation (forecast by EIA to make up virtually all of New England's new generating capacity after 2009), would result in 2020 reductions of only 3 percent versus 2001 levels. (See "Low Reduction Case" in Fig. 8.) Both cases assume the retirement of New England's nuclear reactors at the expiration of their current licenses.

Figure 8. New England Projected Carbon Dioxide Emissions from Electricity Generation (thousand MTCE)[105]



Decisions regarding the level of a regional carbon cap will invariably take many factors into account beyond achieving the maximum carbon dioxide emission reductions. It is likely that emission reductions from a well-structured cap would fall somewhere within the range of reductions estimated here. However, it is also possible that an aggressive regional effort to promote renewables could enable them to become economically competitive with other forms of generation. Were that scenario to take place, the level of emission reductions possible under a carbon cap would be significantly greater.

1) Reduce energy use in state facilities by 25 percent by 2010.

The state has already committed to reducing government energy use by 25 percent by 2011. To meet this goal, the state will need to begin taking action now.

State government can achieve significant energy savings through several measures, including an aggressive building retrofit program. The state's recent adoption of the Leadership in Environmental & Energy Design (LEED) standards as the goal for all new state buildings will provide significant energy savings in new and remodeled state buildings. The state can do more by aggressively retrofitting existing buildings.

The state should seek to retrofit at least half of all state buildings for improved energy efficiency by 2010. A potential model for an expanded building retrofit effort is the Building Energy Conservation Initiative (BECI) in New Hampshire, under which 1.2 million square feet of office space have been retrofitted for efficiency improvements, saving an estimated 26 billion BTU of site energy each year.[107] Efficiency improvements under the program are paid for from the projected savings in energy costs resulting from the project. Only projects that can be demonstrated to be cost-effective can be undertaken through the program.

2) Improve the energy efficiency of the state vehicle fleet.

Maine's primary state government fleet consists of thousands of cars and light trucks. The state's highway division owns additional trucks and heavy equipment. Vehicles in all state and local government fleets in Maine consumed 9.6 million gallons of gasoline in 2001, according to the Federal Highway Administration, representing over 1 percent of total gasoline use in the state.[108]

To improve the energy efficiency of the state fleet, Maine should purchase of the most efficient vehicle that will serve the given governmental purpose, within a reasonable cost premium. The fuel economy spectrum in many classes of vehicles is wide – in the light-duty sector, the most fuel-efficient vehicle in each class in 2003 ranged from 13 percent to 140 percent more efficient than the average vehicle.[109] Maine has a policy in place that state agencies should purchase "the most fuel efficient, lowest emission vehicle in the class of vehicle required" provided it meet other criteria such as lifecycle costs.[110] The state should make this policy permanent, and the Department of Administrative and Financial Services should ensure that all agencies comply.

Second, Maine should restrict the use of sport utility vehicles to those government functions in which four-wheel-drive and off-road capabilities are truly required. Doing so will likely not only reduce energy consumption, but will also save taxpayers money.

Finally, Maine should implement a purchasing strategy for alternative-fuel vehicles that emphasizes technologies that are inherently low-carbon. The federal Energy Policy Act (EPACT) of 1992 requires 75 percent of applicable light-duty vehicles purchased by state governments to operate on alternative fuels. Unfortunately, EPACT includes several perverse incentives and disincentives. For example, flexible-fuel vehicles that can operate on either gasoline or an alternative fuel receive EPACT credit, even if they never operate on the alternative fuel. On the other hand, hybrid-electric vehicles are excluded from EPACT credit, despite their superior efficiency. Maine and other New England states should urge revisions to EPACT that would enhance the program's effectiveness as an emissions reduction tool.

3) Purchase 50 percent of state government's electricity from clean renewable sources by 2020.

Enlisting Maine state government as a purchaser of renewable electricity would provide yet another incentive for the development of wind, solar and other forms of renewable power in the state and region. Government purchases of "green power" would be over and above the levels of renewable power required by the Renewable Portfolio Standard and should include the development of distributed renewable resources on state buildings and land, such as rooftop solar systems, where appropriate.

Governor Baldacci has already established a target of buying 50 percent of the state's power from renewable sources, but has not specified a target date. Currently, 40 percent of the state's electricity comes from renewable energy. The state plans to offset any increased cost from buying renewable energy with efficiency improvements in state buildings. The state should commit to reaching its 50 percent target by 2020 or sooner.

4) Encourage public sector improvements outside of state government.

Municipal governments in Maine are also major consumers of energy. The state should use its role as a partial funder of school and other local construction projects to drive improvements in energy efficiency for those projects. Similarly, the state should help municipalities to develop market power in the purchase of efficient vehicles and equipment.

Strategy #14: Develop and Implement a Global Warming Emissions Registry

Potential Savings: Not estimated.

A registry system for recording and tracking global warming emissions is a key piece of infrastructure in Maine's efforts to reduce its contribution to global warming. At present, Northeast States for Coordinated Air Use Management (NESCAUM) is developing a registry system for the region that will likely be operable by the end of 2005. Initially, the system will focus on recording emissions from the electric power industry, but it could also be used as a way for entities to voluntarily record their baseline global warming emissions and reductions over time.

Massachusetts, for example, has already adopted regulations requiring older coal and oil-fired power plants to report their carbon dioxide emissions. Unlike NESCAUM's voluntary registry, Massachusetts' will require power plants to report their emissions. The program's details have not yet been established, but likely will involve independent monitoring of emissions in addition to self-reporting.

Maine currently is finalizing a mandatory reporting system for larger facilities. Maine would do well to broaden its program to include all sources of global warming emissions. Likewise, it should ensure that its requirements are consistent with the NESCAUM registry.
The impact of a registry system like NESCAUM's (beyond its role in implementing an electric sector carbon cap) is difficult to determine, particularly in the short run. However, once developed, a registry system could eventually be adapted to promote either market-based (trading) or regulatory approaches to the reduction of global warming emissions. Eventually, entities responsible for large-scale emissions of global warming emissions should be required to report their emissions to the registry. Maine could help pave the way in the region.

The Impact of the Strategies

Short- and Medium-Term Impacts

The 14 strategies listed above would not be enough – on their own – to achieve the regional short- and medium-term global warming gas reduction goals within Maine. But, combined with other positive strategies discussed by the New England governors, other policy options suggested in this report, and action at the federal level in areas in which Maine's freedom of action is limited, they can put the state on a solid footing to achieve its goals.

We estimate that the strategies listed above would reduce Maine's direct emissions of carbon dioxide by 5 percent below the level currently projected for 2010 and by 11 percent below the level currently projected for 2020. Direct emissions would be about 16 percent above the 2010 target emissions level (which is to return to 1990 levels) and 31 percent above the 2020 target (which is to reduce emissions by 10 percent below 1990 levels). Even with these strategies, emissions would rise slightly from 2010 to 2020 (from 16 percent above 1990 levels in 2010 to 18 percent above 1990 levels in 2020). (See Fig. 9.)

Regionally, the combination of reduced electricity consumption in the residential, commercial and industrial sectors with the increased use of renewable sources of energy would result in a significant reduction in carbon dioxide emissions from the electricity sector. The 14 strategies above would reduce carbon dioxide emissions from power generation in New England by about 2,100-4,800 thousand MTCE by 2010 and 4,300-7,700 thousand MTCE by 2020 below projected levels.

Were all six New England states to adopt all 14 strategies, the region would take significant strides toward achieving the goals of the New England governors' and eastern Canadian premiers' climate change action plan. Total carbon emissions would be reduced by 17-23 percent versus projected levels by 2020, depending on the final level of any regional carbon cap. With a carbon cap that allowed the displacement of coal-fired generation and the adoption of all 14 strategies in all six states, carbon dioxide emissions in 2010 would be about 8 percent above 1990 levels (compared to the regional goal of attaining 1990 emissions levels by 2010). Emissions in 2020 would be about 21 percent above the regional goal (which is to reduce emissions to 10 percent below 1990 levels by 2020). Even with the strategies in place, emissions from 2010 to 2020 would rise slightly, from 8 percent over 1990 levels to 9 percent over 1990 levels.

The adoption of these 14 strategies by all New England states, therefore, would allow the region to achieve about 70 percent of the reductions targeted for 2010 in the regional accord (reducing emissions to 1990 levels). For 2020, the New England states would be 60 percent of the way to meeting the medium-term goal (reducing emissions to 10 percent below 1990 levels). The adoption of additional strategies identified in this report could help in closing the gap.

Putting It in Perspective – Achieving the Long-Term Goal

Ultimately, Maine's efforts to reduce global warming emissions will be judged not by the state's ability to achieve interim goals, but by the speed with which the state can reduce – and eventually eliminate – its contribution to the degradation of the climate. Achieving the long-term reductions in emissions of 75-85 percent that scientists believe will be needed to eliminate any harmful threat to the climate is the true test by which the state's efforts must be assessed, and should remain the overarching goal.

Figure 9. Projected Direct Carbon Dioxide Emissions in Maine (thousand MTCE)

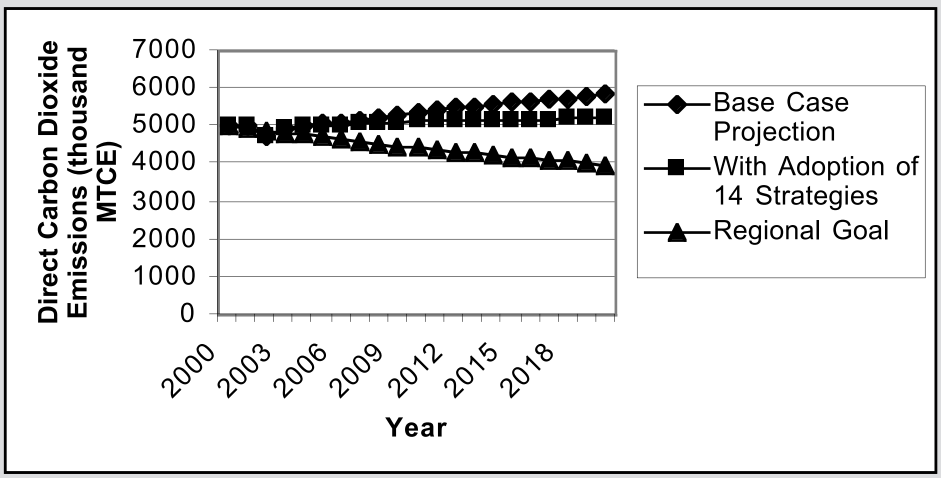


Figure 10. New England Projected Carbon Dioxide Emissions (thousand MTCE)

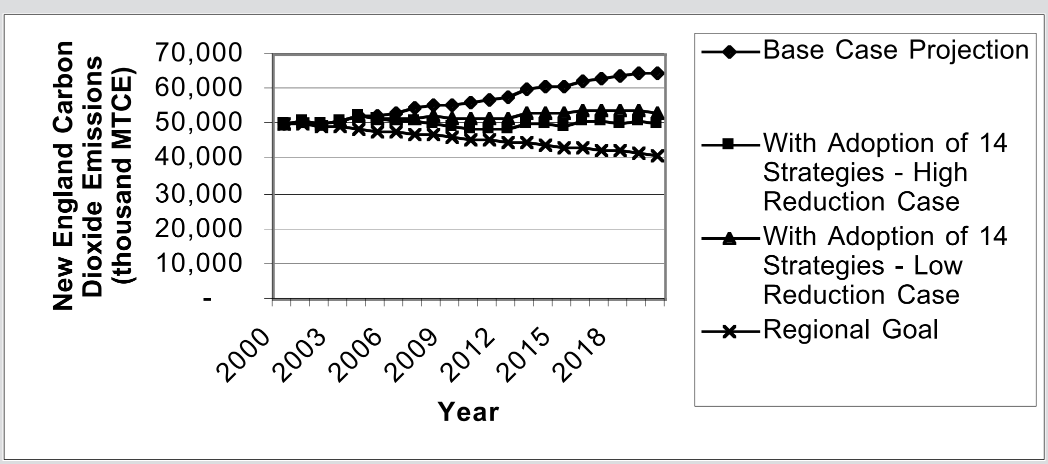


Table 5. Carbon Dioxide Emission Reductions from Strategies and Additional Reductions Required to Meet Regional Goals (thousand MTCE)

	1990	2000	2010	2020
MAINE DIRECT CARBON DIOXIDE EMISSIONS				
Historic/*Projected Emissions*	4,430	5,020	*5,390*	*5,840*
Regional Goal			4,430	3,980
Reductions Needed to Achieve Goal			960	1,860
Reductions from 14 Strategies			250	636
Additional Reductions Needed			710	1,220
NEW ENGLAND ELECTRIC SECTOR EMISSIONS				
Historic/*Projected Emissions*	12,000	12,600	*13,800*	*17,000*
Regional Goal			12,000	10,800
Reductions Needed to Achieve Goal			1,820	6,180
Reductions from 14 Strategies (High/Low Case)			4,810/2,100	7,700/4,300
Additional Reductions Needed			0/0	0/1,850

The 14 strategies above not only move Maine far toward achievement of the short- and medium-term goals, but they also begin to lay the groundwork for a deeper transition that will bring the long-term goals within reach. In the transportation sector, swift implementation of a clean cars requirement will ensure the placement of tens of thousands of high-efficiency hybrid vehicles on Maine's roads, while focusing the research energy of automakers on the development of the next generation of clean automobile technologies. The Pavley program, if properly designed and implemented, will create the regulatory framework to ensure that all vehicles make the least possible impact on the climate. New buildings and appliances will have energy efficiency built in, while owners of existing buildings and appliances will be able to take advantage of energy efficiency programs to reduce their energy consumption. Wind power and other renewables will produce much of the electricity Maine uses, while solar panels, fuel cells and other new technologies will be market-ready and prepared to compete with traditional fossil and nuclear electricity.

Even with these advances, Maine will still face difficult challenges. Our communities will have to be reshaped to rely less on individual cars and trucks to transport people and goods. Our economic system will have to reflect more fully the environmental and public health costs of the energy we use, and provide the capital needed to make the transition to cleaner and more efficient ways of living and doing business. Emissions of other global warming gases will have to be reduced dramatically. And other states, regions and nations far from Maine will have to do their share as well.

Affecting these changes will require an unprecedented amount of research, discussion, cooperation and political will – as well as a commitment to achieve the long-term goal within a reasonable time frame; for example, by 2050. The early signs are positive: Maine and the other New England states are now engaged in the discussion and study of global warming, its impacts, and the means of addressing the problem in a way they have never been before. But the critical test – implementation – lies ahead.

The strategies laid out in this report show the way forward. By using existing technologies and reasonable public policy tools, Maine can make large strides toward reducing the state's contribution to global warming in the near term, while in many cases improving public health, economic well-being and energy security, and providing a model of leadership for others to follow.

Emission-Reduction Strategies in Connecticut and Rhode Island

Stakeholder groups in Connecticut and Rhode Island have recommended emission-reduction policies for their states that achieve, or come close to achieving, the regional global warming emission reduction goals. The stakeholder groups, which represent a broad range of interests from government, business and industry, the nonprofit sector and academia, selected policies that they thought would substantially reduce emissions without creating unreasonable requirements for any sector.

Rhode Island: The combined results of the 49 in-state policy options identified in Rhode Island's Greenhouse Gas Action Plan will allow the state to meet the 2020 emissions-reduction target; further reductions can be achieved through recommended policies that involve regional or national coordination. The strategies include:

- *Implementing a fuel-efficiency feebate program*: Purchasers of low efficiency vehicles would pay a fee, while purchasers of more efficient vehicles would receive a rebate.
- *Improving the efficiency of buildings:* A variety of programs would be created to replace existing equipment in homes and businesses with more energy efficient equipment and to promote the use of efficient combined heat-and-power.
- *Encouraging smart growth*: This would include initiatives to encourage the integration of land-use zoning and transit planning to reduce automobile trips by maximizing walkability, improving bus services, and guiding growth along rail transit routes.
- *Adopting a renewable energy standard*: A minimum percentage of electricity sold in the state would have to come from qualifying renewable resources. The stakeholders estimated the impact of a 20 percent by 2020 target, but did not recommend specifics for the policy, and agreed that further assessment would be needed.

Connecticut: The Connecticut Climate Change Stakeholder Dialogue's 55 recommendations come close to achieving the 2020 regional target. The Connecticut plan recommends:

- *Adopting the California clean car standards*: Strict emission standards for all new cars sold beginning in model year 2007 would reduce emissions from the transportation sector. The state has adopted this policy.
- *Creating a greenhouse gas feebate program*: Purchasers of high greenhouse gas-emitting vehicles would pay a fee, while purchasers of low emitting vehicles would receive a rebate.
- *Improving efficiency in homes*: This would decrease energy use in houses by requiring new buildings to meet the most recent energy code, expanding the rebates offered under the Energy Star Homes program, and providing funding to double the number of houses served under the federal Weatherization Assistance Program.
- *Adopting a renewable energy strategy*: The state would extend its existing renewable energy standard for electricity generation, require that state government and universities purchase a percentage of their electricity from zero-emission renewables, and offer a tax credit for qualifying renewable energy production.

Methodology and Technical Discussion

General Assumptions and Limitations

This report relies primarily on data and projections from the U.S. Energy Information Administration (EIA) to estimate past, present and future global warming gas emissions in Maine. Future emission trends in Maine are generally based on EIA's projected rates of growth for New England as a whole. Maine trends will differ, but the EIA growth projections provide a reasonable approximation of future trends, particularly given the regional context of Maine's global warming emission reduction efforts.

EIA's projections of future energy use – as published in the *Annual Energy Outlook 2003* (AEO 2003) – are intended to reflect all federal, state and local legislation adopted as of September 1, 2002. Several policy changes adopted after that date will have an impact on carbon dioxide emissions in Maine (including the more stringent CAFE standard for light trucks). We have not attempted to revise EIA's assumptions to reflect these changes.

This analysis focuses exclusively on emissions of carbon dioxide from energy use in Maine and New England. The exclusion of other global warming gases from this analysis is not intended to minimize their importance, but is the result of time and resource limitations.

This report also limits its scope of analysis to the six New England states. Several of the policies described here could have effects outside the region that would either create additional carbon dioxide emissions or reduce emissions further than projected here. Because global warming is a global problem, it is important to consider these potential spill-over effects when setting policy, but it is beyond the scope of this report to do so.

All fees, charges and other monetary values are in 2003 dollars and are assumed to be indexed to inflation. In other words, the systems benefit charge assessed on electricity purchases in 2020 is assumed to have the same buying power as a 5-mill charge would have in 2003.

Baseline Emission Estimates

Baseline estimates of carbon dioxide emissions from energy use for 1990 were based on energy consumption data from EIA, *State Energy Data 2000* (SEDR 2000). To calculate carbon dioxide emissions, energy use for each fuel in each sector (in BTU) was multiplied by carbon coefficients for 1990 as specified in EIA, *Emissions of Greenhouse Gases in the United States 2001*, Appendix B.

Significant changes in EIA's methodology for collecting and presenting data render some information in *SEDR 2000* unreliable for estimating 2000 carbon dioxide emissions, and require adjustments in the 1990 data. Specifically, EIA has changed the sources of some of its energy use data and reallocated energy use and emissions from non-utility producers of power from the industrial to the electric sector.

There were several possible methods for obtaining state-specific energy use data for fuels and sectors in which *SEDR 2000* data are inaccurate. Our approach was to seek out the most recent available data from EIA's fuel-specific reports or follow EIA-specified methodologies for adjusting data presented in *SEDR 2000*.

The 1990 figures for natural gas usage in each sector were adjusted upward by 2.3 percent, corresponding with the upward revision in national natural gas use figures as reported in EIA, *Emissions of Greenhouse Gases in the United States 2001*. The allocation of coal use and emissions between the industrial and electric sectors was adjusted as described for 2000 data below.

The following sources and methods were used by fuel:

- **Coal** – For both 1990 and 2000, coal use and emissions were reallocated between the industrial and electric sectors based on the following method, adapted from EIA, *Emissions of Greenhouse Gases in the United States 2000,* Appendix A:

    1) Total coal use for all sectors in BTU was obtained from *SEDR 2000*.

    2) Residential and commercial coal use in BTU was subtracted from the total, leaving total industrial and electric sector consumption.

    3) Electric utility consumption was then subtracted from total electric-plus-industrial consumption. Utility consumption was estimated by multiply-

ing utility consumption of coal in short tons from EIA, *Electric Power Annual 2001, Consumption by State* by the appropriate heat rate for Maine, obtained from EIA, *SEDR 2000*, Appendix B.

4) Consumption by non-utility power producers was estimated by multiplying the remaining coal consumption from the electric power sector (from *Electric Power Annual 2001*) by the appropriate heat rate.

5) Estimated consumption by utility and non-utility power producers was summed to arrive at total electric energy use from coal. This figure was then subtracted from the electric-plus-industrial consumption estimate to arrive at estimated consumption in the industrial sector.

- **Natural Gas** – Sector-specific natural gas consumption data for Maine in million cubic feet were obtained from EIA, *Maine Natural Gas Consumption by End Use*, downloaded from http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_sme_m_d.htm, updated 21 August 2003. Consumption data were converted to BTU values using thermal conversion factors from *SEDR 2000*.

- **Petroleum** – Data for consumption of distillate and residual fuel by sector was obtained from EIA, *Fuel Oil and Kerosene Sales 2001*, and then converted to BTU values using heat rates from *AEO 2003,* except for the use of petroleum in the electric power sector, which was obtained from EIA, *Electric Power Annual 2001,* spreadsheets, Consumption by State. Estimated use of other petroleum products was based on *SEDR 2000*.

Several additional assumptions were made:

- Carbon dioxide emissions due to electricity imported into New England were not included in the emissions estimates, nor were "upstream" emissions resulting from the production or distribution of fossil or nuclear fuels.

- Combustion of wood and other biomass was excluded from the analysis per EIA, *Emissions of Greenhouse Gases in the United States 2001*, Appendix D. This exclusion is justified by EIA on the grounds that wood and other biofuels obtain carbon through atmospheric uptake and that their combustion does not cause a net increase or decrease in the overall carbon "budget."

- Electricity generated from nuclear and hydroelectric sources was assumed to have a carbon coefficient of zero.

- Carbon emissions from the non-combustion use of fossil fuels in the industrial and transportation sectors were derived from estimates of the non-fuel portion of fossil energy use and the carbon storage factors for non-fuel use presented in U.S. EPA, *Comparison of EPA State Inventory Summaries and State-Authored Inventories*, downloaded from http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/JSIN5DTQKG/$File/pdfB-comparison1.pdf, 31 July 2003. To preserve the simplicity of analysis and to attain consistency with future-year estimates, industrial consumption of asphalt and road oil, kerosene, lubricants and other petroleum, and transportation consumption of aviation gasoline and lubricants were classified as "other petroleum" and assigned a carbon coefficient of 20 MMTCE per quad BTU for that portion that is consumed as fuel.

Known Discrepancies with Other Published Estimates

Due to variations in methodology, the adjustment of energy use figures over time, and inherent disagreement in the data presented in various EIA reports, the emissions estimates for 2000 presented here differ somewhat from regional emission estimates derived from *AEO 2003*.

Because the estimates for this report were compiled using a common methodology applied to all six New England states, it is also possible to compare the regional total emissions estimate with estimates derived from *AEO 2003* and presented in the New England Climate Coalition's 2003 report, *Global Warming in New England*. Estimated 2000 carbon dioxide emissions for the region based on the sources and methodology in this report are about 3 percent lower than estimated emissions based on *AEO 2003*'s regional energy use figures – assuming the continued operations of the region's nuclear power plant in both cases. Specifically, the methodology of this report appears to significantly underestimate emissions from petroleum use in the commercial sector and natural gas use in the industrial sector and to overestimate emissions from natural gas use in the commercial sector when compared to estimates based on *AEO 2003*. These discrepancies are likely due to the use of varying EIA reports for fuel use estimates. The expected publication of an updated version of *SEDR* in 2004 should clear up these discrepancies and we encourage a revisiting of the data at that time.

Future Year Projections

Projections of energy use and carbon dioxide emissions for Maine are based on applying the New England year-to-year projected growth rates for each fuel in each sector from *AEO 2003* to the Maine baseline emissions estimate for 2000, with two exceptions.

1. In the transportation sector, EIA's estimates of vehicle travel increases are significantly higher than projections produced by the Maine Department of Transportation and recent experience in the state. Instead of using EIA's projected growth rates for motor gasoline use, we used a growth rate of 0.9 percent per year, commensurate with Maine DOT's projections of vehicle miles traveled increases for 2002 to 2020, supplied by the department in October 2003. This assumes no improvement or deterioration in light-duty vehicle fuel economy in the aggregate between now and 2020. While it is likely that EIA's methodology also overstates emissions for diesel fuel use, we used the EIA assumptions because of the difficulty of disaggregating vehicular diesel fuel use from use by other transportation modes.

2. Unlike EIA, we assume that nuclear reactors in New England are retired at the expiration of their current operating licenses. Thus, the regional base case estimate for power-sector energy use was adjusted by eliminating nuclear generation from the power-sector energy mix for nuclear plants whose licenses expire and replacing that power with gas-fired generation. The level of electric-sector natural gas consumption needed to replace nuclear generation was estimated by multiplying the amount of nuclear energy consumption based on *AEO 2003* by the ratio of the calculated heat rate for natural gas generation divided by the imputed heat rate for nuclear generation, based on data from Supplementary Table 66 of *AEO 2003*. Heat rates were calculated by dividing energy consumption for each fuel by net generation for each fuel. This method will tend to slightly overstate energy use – and therefore emissions – from natural gas, since it is likely that new natural gas-fired generation will be more efficient than the average efficiency of all natural gas plants in the region for any given year.

Carbon Dioxide Reductions from Electricity Savings and Renewables

Carbon dioxide reductions for measures that reduce electricity use or expand renewable resources were generally estimated based on the impact of the reductions on the entire New England grid. For individual strategies, a range of savings were projected based on two sets of assumptions:

- **Low savings estimate** – Based on the use of efficiency savings and renewables to offset natural gas generation on the New England grid, which is projected by EIA in *AEO 2003* to account for virtually all of New England's new electric generating capacity beyond 2009. The formulas used to calculate these reductions are similar to those described above for the replacement of nuclear power in the base case, with differences in heat rates among the fuels used to estimate the amount of generating capacity that would be displaced. This case is intended to replicate a scenario in which efficiency and renewable savings are used to avoid the need to construct new generating capacity in the New England grid, rather than retire less-efficient old generators.

- **High savings estimate** – Based on the use of efficiency savings and renewables to first offset power loss through the closure of in-state nuclear plants whose licenses have expired, then to offset generation on the New England grid with the highest carbon dioxide emissions, first coal, then petroleum. The assumed offset of coal-fired generation may not yield the maximum carbon reduction possible under a regional carbon cap, some since oil-fired generating units in New England produce greater carbon dioxide emissions per unit of delivered electricity than coal-fired plants. The examination of plant-by-plant data was, however, beyond the scope of this report. As a result, the simplifying assumption to reduce coal-fired generation likely produces a conservative estimate of the maximum potential benefit of an electric-sector carbon cap.

The two estimates suggest the potential impact of an electric-sector carbon cap, with greater savings arising from a strong cap that creates pressure to retire old generation (the high savings estimate) and lesser savings arising from a weak cap or the absence of a cap (the low savings estimate). In reality, it is likely that both the high and low estimates are somewhat extreme – that is, that some old coal-fired generation would be retired in the absence of a cap and that some small amount may remain even with a cap.

In addition, all electricity-related estimates assume that New England produces all the power it consumes and is neither a net importer nor a net exporter of electricity. The potential for "leakage" of emission reductions – in which public policies result in increased importation of high-emission electricity from elsewhere, thus leading to greater emissions in the aggregate – is an important issue for policy-makers to address, but was beyond the scope of this report to incorporate.

Transportation Sector Strategies

All estimated reductions from transportation-sector strategies were derived by estimating the percentage reductions in light-duty vehicle motor gasoline use from the baseline arrived at by the methods above. Light-duty vehicle gasoline use was estimated by multiplying the motor gasoline baseline by the percentage of motor gasoline used by light-duty vehicles, derived from the supplementary tables to *AEO 2003*.

Percentage reductions were calculated by multiplying grams/mile emission factors for carbon dioxide, based on a modified version of the Argonne National Laboratory's GREET model, version 1.5a, by the projected percentages of VMT driven by vehicles of various classes, types and ages, estimated as described below. Estimates for light-duty carbon dioxide emissions were based on the following sources:

- **Vehicle-miles traveled (VMT) percentages** – VMT percentages by vehicle class were derived by dividing projected national light-duty VMT for each year by the projected national light-duty vehicle stock as reported in supplementary tables to *AEO 2003*. This average VMT/vehicle/year figure was then adjusted to reflect the slightly higher VMT/vehicle/year of passenger cars vs. light trucks (based on a two-year average of VMT/vehicle derived from FHWA data) and multiplied by the projected nationwide passenger car and truck stocks in *AEO 2003*. Light-duty truck VMT was further divided into heavy and light categories by multiplying the total truck VMT by vehicle stock percentages contained in EPA, *Fleet Characterization Data for MOBILE6*, September 2001. The projected VMT for each vehicle class was then divided by the total light-duty VMT to arrive at the percentage of total VMT traveled by vehicles in each class in each year.

  VMT were further disaggregated into VMT by model year and vehicle class for each year between 2001 and 2020, based on estimates of VMT accumulation rates presented in EPA, *Fleet Characterization Data for MOBILE6*. No attempt was made to customize the national VMT percentages for Maine.

- **Carbon dioxide emission factors** – Grams-per-mile emission factors for each model year and class were based on modifications to the GREET model, version 1.5a. For conventional gasoline vehicles, the only modification to the model was the substitution of "real-world" fleet average miles per gallon (MPG) estimates for each model year from 1970 to 2020. For 1975 through 1999, real-world MPG was calculated by multiplying EPA-rated MPG for cars and light trucks (as reported in EPA, *Light Duty Automotive Technology and Fuel Economy Trends, 1975 Through 2003*, April 2003) by an adjustment factor of 0.8. For model years prior to 1975, 1975 figures were used. For 2000-2020, new car and truck on-road miles per gallon was based on Supplementary Table 49 to *AEO 2003*.

  Real-world MPG projections were then input into the GREET model, producing grams-per-mile carbon dioxide emission factors for vehicle operations. Carbon dioxide emissions stemming from feedstock and fuels were not included in this analysis. The resulting emission factors for vehicles greater than three years old were then divided by 0.97 to account for the loss of fuel economy resulting from the replacement of low-rolling resistance tires with less-efficient replacement tires.

For vehicles covered by the Zero Emission Vehicle program, vehicles sold to meet the program's obligation for Advanced Technology Partial Zero-Emission Vehicle (AT-PZEV) credits were assumed to be hybrids, producing the same per-mile emissions as default hybrid vehicles in the GREET model, and vehicles sold to meet the obligation for pure Zero Emission Vehicle (ZEV) credits were assumed to be GREET model-default hydrogen fuel-cell vehicles. Because hydrogen fuel-cell vehicles emit no pollutants in vehicle operation, life-cycle carbon dioxide emissions were used. This assumption may result in a higher estimate for in-state carbon dioxide emissions from fuel-cell vehicles because it is unclear whether the conversion from natural gas to hydrogen would take place locally (thus resulting in carbon dioxide emissions) or at an out-of-state location.

Zero-Emission Vehicle Program

Percentages of conventional, AT-PZEV and ZEV vehicles that would be sold in Maine under the ZEV program were derived from projections of vehicle sales in California under the ZEV program in Chuck Shulock, California Air Resources Board, *The California ZEV Program: Implementation Status*, presented at EVS-20, the 20th International Electric Vehicle Symposium and Exposition, November 2003. ZEV program implementation was assumed to begin in 2007. The sale of pure ZEVs was assumed to not be required until 2012 per recent proposed changes in the California ZEV rule. Estimates of California sales may not translate accurately to Maine due to automakers' accumulation of banked credits that can be used to reduce ZEV program obligations in the early years of the program in California.

To adjust for the presumed inclusion of earlier ZEV program requirements in *AEO 2003* projections, savings from the ZEV program were reduced by the estimated reductions of the previous (2001) version of the ZEV program, with estimated ZEV sales percentages derived from a spreadsheet supplied by CARB based on the 2001 ZEV amendments, with all pure ZEVs under the old scenario presumed to be full-function battery-electric vehicles.

California Vehicle Carbon Dioxide Limits

Emission factors for new conventional vehicles (i.e. those not used to obtain ZEV or AT-PZEV credits) under this scenario were assumed to be reduced by 30 percent between 2009 and 2019, with reductions taking place in a linear fashion over that time period. Because California has not yet proposed final regulations for implementing tailpipe carbon dioxide limits, it is impossible to know whether ultimate reductions will be greater or less than the 30 percent estimated here.

Low-Rolling Resistance Tires

Savings from the use of low-rolling resistance replacement tires were estimated by reducing carbon dioxide emission factors by 3 percent from baseline assumptions for vehicles reaching four, seven and 11 years of age beginning in 2005, per California Energy Commission, *California Fuel-Efficient Tire Report, Volume II*, January 2003. This estimate assumes that the tire stock will completely turn over; that is, that LRR tires will supplant non-LRR replacement tires in the marketplace through a state requirement. Other policies to encourage, but not mandate, LRR tires will likely produce reduced savings.

Feebate

Potential savings from a feebate program are based on estimated fuel economy improvements from a California state feebate program in *Reducing California's Petroleum Dependence* (California Energy Commission and California Air Resources Board, Final Staff Report, August 2003, Appendix C, Attachment B, B-251). Improvements in fuel economy translate to a 4.2 percent reduction in carbon dioxide emissions per mile for new cars by 2010 and an 8.2 percent reduction by 2020. For light trucks, estimated reductions in carbon dioxide emission rates are 5 percent by 2010 and 8.4 percent by 2020. Improvements in fuel economy are assumed to take place linearly beginning in 2005. The impact of a feebate program in Maine could be greater or less than the California program studied depending on the scope of the program and its design.

Pay-As-You-Drive Automobile Insurance

Estimates of the impact of PAYD insurance are based on the assumption that 80 percent of collision and liability insurance payments in Maine would be transferred to a mileage-based system, with participation in the system increasing by 10 percent per year from 2005 to 2010, and 50 percent of all light-duty drivers participating in the system from 2010 to 2020. The average per-mile cost of insurance was computed by multiplying the average expenditure on collision and liability insurance in Maine in 2001 as reported in *Facts and Statistics: The Rising Cost of Auto Insurance* (Insurance Information Institute, downloaded from www.iii.org/media/facts/statsbyissue/auto/content.print/, 29 October 2003) by the number of light-duty vehicle registrations in Maine from FHWA, *Highway Statistics 2001*. This total expenditure figure was then divided by light-duty VMT derived from adjusted FHWA figures to arrive at an average per-mile cost for liability and collision insurance. This per-mile cost was then multiplied by 0.8 to account for any non-mileage related aspects of liability and collision coverage and to ensure the conservatism of the estimate, yielding an average per-mile charge of 3.2 cents. The estimated reduction in VMT that would result from such a charge was obtained from *Online TDM Encyclopedia: Pay-As-You-Drive Vehicle Insurance* (Victoria Transport Policy Institute, downloaded from http://www.vtpi.org/tdm/tdm79.htm, 3 December 2003). It was assumed that the decrease in VMT (5.1 percent) for drivers participating in the program would take place beginning immediately upon program implementation in 2005.

VMT Stabilization

VMT increases in this scenario are estimated to reflect Maine's projected rate of population growth between 2006 and 2020 per *Projections of the Total Population of States: 1995 to 2025*, (U.S. Census Bureau, downloaded from www.census.gov/population/projections/state/stpjpop.txt, 12 December 2003).

Combination of Transportation Strategies

Combined emission reduction estimates from the transportation strategies were derived by multiplying the percentage of emissions remaining from each of the strategies by the percentage remaining from the other strategies. The impact of a feebate program is not included in the combined policy case because it is difficult to ascertain how such a program would interact with carbon dioxide tailpipe standards.

Other Transportation Assumptions

- We assume a "rebound effect" of 20 percent on all measures that improve fuel economy or reduce per-mile carbon dioxide emissions. The rebound effect occurs when reduced per-mile costs of driving (such as would result from purchasing a vehicle with better fuel economy) encourage drivers to increase their VMT.
- We assume no mix shifting effects from any of the above policies. In other words, we assume that the strategies would not encourage individuals who would have purchased a car to purchase a light truck, or vice versa. It is likely that at least some mix shifting would occur as a result of some of the policy strategies (for example, high feebate charges encouraging individuals to shift from light trucks to cars), but we believe that the policies could be appropriately designed to ensure that any mix-shifting effects would serve to further reduce (rather than increase) carbon dioxide emissions.

Residential, Commercial and Industrial Strategies

Building Energy Codes

The projected impact of residential energy codes was derived by estimating the percentage of residential energy use that would take place in new homes under EIA projections and applying estimated percentage reductions in energy use that would take place under updated codes. Revised codes were not assumed to affect energy use in existing homes.

The proportion of projected residential energy use from new homes was derived by subtracting estimated energy use from homes in existence prior to 2004 from total residential energy use for each year based on *AEO 2003* growth rates. Consumption of energy by surviving pre-code homes was calculated by assuming that energy consumption per home remains stable over the study period and that 0.4 percent of homes are retired each year, per EIA, *Assumptions to AEO 2003*.

Energy savings from updating Maine's residential building code to 2000 IECC standards is assumed to be 15 percent below projected levels for 2004-2010, based on Steven Nadel and Howard Geller, American Council for an Energy-Efficient Economy (ACEEE), *State Energy Policies: Saving Money and Reducing Pollutant Emissions Through Greater Energy Efficiency,* September 2001. Energy savings from future updates to residential building codes were assumed to be 32 percent below current projections for 2011-2020, also based on ACEEE. Energy savings from residential building energy codes were assumed to take place equally among the various fuels.

For commercial building codes, New England-specific commercial building retirement percentages were estimated by determining the approximate median age of commercial floorspace in New England based on data from EIA, *1999 Commercial Building Energy Consumption Survey* (CBECS), estimating a weighted-average "gamma" factor (which approximates the degree to which buildings are likely to retire at the median age), and inputting the results into the equation, *Surviving Proportion=1/(1+(Building Age/Median Lifetime)^{Gamma}* as described in EIA, *Model Documentation Report: Commercial Sector Demand Module of the National Energy Modeling System*, March 2003. Baseline 2003 commercial energy demand was then multiplied by the percentage of surviving pre-code commercial buildings to estimate the energy use from buildings not covered by the code. For buildings covered by the code, all savings between 2005 and 2010 were assumed to be reflected in the baseline energy use estimate derived from EIA projections. The adoption of future upgrades to commercial energy codes was estimated to result in a 20 percent reduction in the use of all fuels in new construction from 2011 to 2020 per Nadel and Geller (ACEEE), *State Energy Policies.* No attempt was made to estimate the impact of commercial code revisions on energy use due to renovations of existing commercial space.

Appliance Efficiency Standards

Estimates of potential energy savings from appliance efficiency standards were based on Ned Raynolds and Andrew Delaski, Northeast Energy Efficiency Partnerships, *Energy Efficiency Standards: A Low-Cost, High Leverage Policy for Northeast States*, Summer 2002. Savings were assumed to begin in the adoption year specified in the NEEP report, with savings increasing in a linear fashion until 2020. We assume that standards for all the products listed in the NEEP report are adopted as described, including those subject to federal preemption. Finally, we assume that additional future efficiency standards would yield savings equivalent to 20 percent of the annual savings resulting from the above standards beginning in 2012.

Systems Benefit Charges for Efficiency

Projections of benefits from a 5-mill electric SBC for efficiency were computed based on the average kilowatt -hour/dollar savings rates from five New England SBC-supported programs for the most recent period for which data were available.[111] (Maine was excluded due to a recent transition in the program from utility to state management.) Additional revenues generated by the increased SBC were determined by subtracting the projected revenue from existing SBC programs from projected revenue from a 5-mill efficiency SBC, then multiplying the increased fee by projected electricity use in Maine. These revenues were then multiplied by the average kWh/$ savings rate, with the savings reduced by 33 percent to reflect the likely higher marginal cost of additional kWh savings due to the reduced availability of "low-hanging fruit" as a result of the original SBC programs. This produced an estimate of annual electricity savings as a result of efficiency programs due to the increased SBC. Future year savings from efficiency measures were assumed to be 90 percent of annual savings in the first through fourth years after implementation of the measures, 80 percent in years five through nine, 60 percent in years 10-14 and 50 percent afterward. These estimates are arbitrary, but yield maximum "lifetime" savings of about 12 times annual savings by the end of the study period, a rate lower than most estimates of lifetime savings from efficiency programs. Carbon dioxide savings were then calculated as described in "Carbon Dioxide Reductions from Electricity Savings and Renewables" above.

Savings resulting from the implementation of an oil/gas SBC-type program were estimated based on projected BTU-per-dollar savings rates of the Vermont Gas conservation program, as documented in Center for Clean Air Policy, *Connecticut Climate Change Stakeholder Dialogue: Recommendations to the Governor's Steering Committee*, January 2004. This savings rate was then reduced by 25 percent to ensure the conservatism of the estimate. The rate of the charge was set at 3.5 cents per 100,000 BTU for natural gas and distillate and residual oil used in the residential, commercial and industrial sectors, with the total BTU savings estimated in a manner similar to savings from the 5-mill electric SBC. Carbon dioxide reductions were then estimated by allocating the total BTU savings from the charge proportionally among the three fuel types and then multiplying the result by the appropriate carbon coefficients.

Combined Policy Case

The combined residential, commercial and industrial sector savings exclude savings resulting from appliance efficiency standards that may also be covered by enhanced building energy codes.

Electric Sector Strategies

Renewable Portfolio Standard

The impact of an RPS of 10 percent new renewables by 2010 and 20 percent new renewables by 2020 was estimated by multiplying projected electricity demand in Maine by the percentage of the proposed RPS, which was assumed to be 2 percent of overall electric demand in 2005, with the percentage increasing by 2 percent each year until 2010 and 1 percent per year between 2010 and 2020.

Solar Program Supported by Renewables SBC

The amount of funding that would be provided by a 0.15-mill earmark for solar programs in a renewables SBC was estimated in a similar manner as the SBC programs above, taking into account energy savings from other efficiency strategies in this report and assuming that the renewables SBC is applied only to electricity. The amount of new solar capacity that would be created with that funding was estimated by assuming the rate of subsidy needed to spark installation of solar PV systems. This figure was estimated at $4,000/kW for 2005-2010, $3,000/kW for 2011-2015, and $2,000/kW for 2016-2020. The initial $4,000/kW figure is based on the amount that would be required to increase the breakeven turnkey cost of residential solar to greater than $7,000/kW, per Christy Herig, Richard Perez, Susan Gouchoe, Rusty Haynes, Tom Hoff, *Customer-Sited Photovoltaics: State Market Analysis*, 2002. Figures for later years are conservative estimates based on the anticipated drop in prices for solar PV systems as estimated in U.S. Department of Energy and Electric Power Research Institute, *Renewable Energy Technology Characterizations*, 1997, 4-5, and other sources. Electricity output from this new installed capacity was estimated based on operation at average 18 percent efficiency. All new solar capacity was assumed to be distributed, with no line losses. One-half of the new solar electricity was assumed to count toward fulfillment of RPS requirements, the other half surplus to offset fossil fuel-fired generation. This split is arbitrary, but would allow for the retirement of green tags for the new renewable capacity by individuals and institutions that choose not to redeem them or to account for green power purchasing programs.

State Government Lead-By-Example

Emissions savings from state government are based on three categories of action. In each case, we assumed that government does not grow, an approach that makes our savings estimates conservative.

Data on current state energy use was calculated by computing government energy per capita in Connecticut, Massachusetts, Rhode Island, and Vermont for different fuels. Natural gas usage was calculated based on just Connecticut, Rhode Island, and Vermont. We then multiplied per capita use rates by Maine's 2002 population. Electricity use was based on data provided by the Maine Energy Resources Council. To calculate the emissions savings from reducing energy use in state facilities by 25 percent by 2020, we multiplied the energy savings for each fuel by its carbon coefficient.

Savings from improving the efficiency of the state's vehicle fleet come from both gas and diesel savings. Data for state government transportation fuel use were not available; thus we relied on the Federal Highway Administration's figures for gas use by non-federal governments – meaning our data represents fuel consumption by state, county, and local governments. Total statewide diesel use figures are from the same source. We estimated non-federal public sector diesel use by assuming that government diesel use is the same portion of total diesel use as government gas use is of total gas use. Projected efficiency improvements assume that non-federal government vehicle fleets achieve 20 percent more gallons per mile by 2012 and 28.5 percent more gallons per mile by 2020. We assumed that there would be no rebound effect of increased miles driven. Carbon savings were calculated by multiplying the energy savings for each fuel by its carbon coefficient.

Carbon savings from having state government purchase 20 percent of its electricity from renewable sources by 2010 again relied on data provided by the Maine Energy Resources Council. The calculations assume that the state has already reduces its energy use by 25 percent. The carbon output of the non-renewable electricity assumes that renewable power generation allows the retirement of high-emission coal plants before petroleum-fired plants.

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7. U.S. Environmental Protection Agency, *Global Warming-State Impacts: Maine*, Office of Policy, Planning, and Evaluation, September 1997.

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9. New England Regional Assessment Group, U.S. Global Change Research Program, *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change. Foundation Report*, September 2001.

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27. Ibid.

28. Ibid.

29. Based on 1990 fuel use data from U.S. Energy Information Administration, *State Energy Data 2000*, 151-156 and 2000 fuel use data from *State Energy Data 2000* and other EIA reports. See "Methodology and Technical Discussion" for more information on sources and methods for calculating carbon dioxide emissions from the fuel use data.

30. Historic emissions based on 1990 fuel use data from U.S. Energy Information Administration, *State Energy Data 2000*, 151-156 and 2000 fuel use data from *State Energy Data 2000* and other EIA reports. Projected emissions based on 2000 fuel use data multiplied by year-to-year projected increases for New England from U.S. Energy Information Administration, *Annual Energy Outlook 2003*, 9 January 2003.

31. Estimated rate of increase in fuel use based on year-to-year increases for New England from U.S. Energy Information Administration, *Annual Energy Outlook 2003*, 9 January 2003.

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44. New England Climate Coalition, *Global Warming in New England*, September 2003. Note: Projected base case emissions in this chart may differ with projected New England emissions presented elsewhere in this report due to changes in methodology and assumptions. Emission savings from sector-by-sector commitments in the regional plan are based on an optimistic interpretation of the plan's potential results, compared to the conservative assumptions for the various policy options analyzed in this report. In most cases, policies to implement the plan's commitments have not yet been formed or implemented. The gap between the governors' and premiers' regional commitments and the action plan goal thus represents the minimum amount of additional carbon dioxide reductions the region must achieve.

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50. Increase from 1990 to 2000 is based on Maine-specific EIA fuel use data as described in "Methodology and Technical Discussion." The estimated increase from 2000 to 2020 is based on the projected growth rate in fuel use in New England from EIA," *Annual Energy Outlook 2003*, except for motor gasoline. The rate of growth in motor gasoline use is based on the annual rate of growth in vehicle travel in Maine projected by the Maine Department of Transportation. VMT projections were obtained from Edward Hanscom, Transportation Analysis Section, Maine Department of Transportation, 23 October 2003.

51. To be more precise, motor gasoline combustion accounted for 70 percent of carbon dioxide emissions from transportation in Maine in 2000. About 92 percent of motor gasoline use in the transportation sector is used to power light-duty vehicles. (Source: EIA, *Supplemental Tables to Annual Energy Outlook 2003.*)

52. The ZEV standards have been adopted, or are in the process of being adopted, by seven states: California, New York, New Jersey, Massachusetts, Connecticut, Rhode Island, and Vermont.

53. Based on a possible scenario for manufacturer compliance with the program in California in Chuck Shulock, California Air Resources Board, *The California ZEV Program: Implementation Status*, presented at EVS-20, the 20th International Electric Vehicle Symposium and Exposition, November 2003. The flexibility of the ZEV program means that manufacturers have many possible ways to comply with the requirement; this scenario assumes that manufacturers take full advantage of program provisions that allow them to substitute ultra-clean conventional gasoline vehicles and hybrids for "pure" zero-emission vehicles such as fuel-cell vehicles. Northeast States for Coordinated Air Use Management (NESCAUM) produced an April 2004 model for possible ZEV compliance in Maine that suggested a much lower number of ZEVs (approximately one percent) on the road in 2020.

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56. These results are similar to the 2.25 percent reduction in carbon dioxide emissions in Massachusetts under the ZEV program in 2020 projected by Northeast States for Coordinated Air Use Management (NESCAUM) in *Emissions Benefits of Adopting the LEV II Program in the Northeast* (draft report), May 2003.

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68. See John W. Holtzclaw, Robert Clear, Hank Dittmar, David Goldstein and Peter Haas, "Location Efficiency: Neighborhood and Socio-Economic Characteristics Determine Auto Ownership and Use – Studies in Chicago, Los Angeles and San Francisco," Transportation *Planning and Technology*, 2002, 25:1-27.

69. Note: These projections do not include the impact of a feebate program. It is very uncertain how a feebate program would interact with a program to set standards for carbon dioxide emissions from vehicles. Presumably, a feebate program with a zero point that increases to match the average per-mile carbon emission level of the vehicle fleet would continue to provide an incentive for the purchase of more fuel efficient vehicles, and therefore lead to lower carbon emissions, but the degree of such an incentive is difficult to discern based on the existing literature.

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