Rhode Island Responds to Global Warming

Priority Policies for Reducing Rhode Island's Contribution to Global Warming

RHODE ISLAND PUBLIC INTEREST RESEARCH GROUP EDUCATION FUND

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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. For more information about the New England Climate Coalition, visit www.newenglandclimate.org.

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Executive Summary

Recognizing the threats to the regional economy and the environment presented by climate change and the benefits of early action, the governors of the six New England states and their peers in eastern Canada signed a landmark agreement in 2001 to reduce the region's contribution to global warming.

Rhode Island could significantly reduce its emissions of global warming gases over the next several decades by taking steps now to make the state more energy efficient and reduce the use of fossil fuels.

The six strategies described in this report could make an important contribution toward helping Rhode Island meet the goals laid out by the regional leaders. These six high-yield policies – most of which have been implemented in other states – can reduce Rhode Island's energy consumption (especially of costly fossil fuels), help the state achieve its short- and mid-term global warming emission reduction goals, and help Rhode Island position itself to achieve the long-term goal of reducing the state's emissions of global warming gases to levels that do not have a harmful effect on the climate – a goal that will require emission reductions of 75 to 85 percent below current levels.

Global warming, the result of human activity changing the earth's climate, is a major threat to Rhode Island'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. (See page 9.)

- Average temperatures in Rhode Island have already increased by about 2.3° F since 1895, and the average surface water temperature in Narragansett Bay has risen 3° F since 1950. Precipitation patterns have changed also. (See page 11.)

- Average temperatures in Rhode Island are projected to increase by between 1° F and 10° F over the next century, potentially making Rhode Island's climate more like that of Atlanta, Georgia. (See page 11.)

- The results of these changes could include sea levels as much as 30 inches higher, endangering people, roads, buildings and other infrastructure along Rhode Island's 440 miles of coastline. Other impacts could include degraded air quality, increased heat-related deaths, and changes in fish populations. (See pages 11-12.)

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

- Between 1990 and 2000, Rhode Island's direct, non-electric emissions of carbon dioxide from energy use (such as burning fossil fuels to power cars or heat buildings) increased by approximately nine percent. These emissions of carbon dioxide could increase by as much as 20 percent over the next two decades, with much of the increase taking place in the transportation sector. (See page 12.)

- Rhode Island's consumption of electricity, which is generated throughout New England, rose 14 percent from 1990 to 2000. From 2000 to 2020, New England-wide emissions of carbon dioxide from electricity generation can be expected to increase by about 35 percent if the region's nuclear reactors close at the expiration of their operating licenses to protect the environment and public health and safety. (See page 14.)

To begin to reduce its global warming emissions, Rhode Island should immediately adopt six high-impact policies.

1. Put more hybrid-electric cars (and eventually zero-emitting cars) on Rhode Island's roads over the next two decades by finalizing and implementing the state's **clean cars requirement**.

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

3. Require 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.

4. Implement a strong **renewable portfolio standard** to require more of Rhode Island's electricity to come from new, clean, renewable sources.

5. Adopt **appliance efficiency standards** for a series of residential and commercial products.

6. **Reduce energy use** by increasing funding for energy efficiency programs supported by electricity ratepayers and creating similar energy efficiency programs for natural gas, heating oil and other heating fuels such as propane.

Implementing these six strategies will reduce Rhode Island's direct, in-state (non-electric) releases of carbon dioxide by nearly 300 thousand MTCE in 2020, slightly less than one-third of the 920 thousand MTCE reductions Rhode Island needs to achieve to meet the regional goal for 2020. Futhermore, these six strategies will reduce regional electric sector emissions. New England's emissions from electricty generation would be reduced by 860 thousand MTCE compared to projected levels. (See pages 29-30.)

These strategies would also produce other significant benefits, including reduced emissions of other air pollutants, decreased dependence on imported fuel, more stable and reliable energy supplies, and significant cost savings due to energy efficiency.

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

- Rhode Island should move forward with implementation of all the recommendations contained in the *Rhode Island Greenhouse Gas Action Plan*, and build upon the stakeholder process by continuing dialogue on such difficult issues as reducing vehicle-miles traveled, limiting suburban sprawl, and encouraging the development of non-fossil, non-nuclear sources of energy.

- Rhode Island 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.

- Rhode Island 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.

- Due to the public health dangers of nuclear power, Rhode Island should reduce its global warming emissions without the use of nuclear energy, either in the state or the region.

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

Policy	2010	2020
Clean Cars Requirement	6.0	32
Carbon Dioxide Tailpipe Standards	8.8	96
Pay-As-You-Drive Auto Insurance	54	59
Renewable Portfolio Standard	100-240	220-530
Appliance Efficiency Standards	29-63	84-180
Expanded Energy Efficiency Programs	87-120	200-290

Introduction

Scientists have concluded that human activities – particularly the burning of fossil fuels – are warming the planet. Yet, at the federal level, political consensus to address the problem has been lacking.

In New England, concern about the potential effects of global warming on the region has begun to mature into a political consensus that something must be done – as evidenced by the landmark commitment made by New England's governors and the premiers of the eastern Canadian provinces in 2001 to reduce the region's emissions of global warming pollution. The governors' and premiers' Climate Change Action Plan committed the region to reducing its global warming emissions to 1990 levels by 2010, to 10 percent below 1990 levels by 2020, and eventually by the 75 to 85 percent below 2001 levels scientists believe will be necessary to prevent dangerous interference with the climate.

Rhode Island acted quickly after signing the Climate Change Action Plan. In 2001, the state initiated the Greenhouse Gas Stakeholder Process to develop a plan for reducing the state's emissions of global warming gases. Stakeholders representing business, industry, government, the nonprofit sector, and environmental organizations agreed on 49 policies that could be adopted at the state, regional, and federal level to reduce Rhode Island's greenhouse gas pollution. The stakeholder recommendations provide a blueprint for Rhode Island to follow in its efforts to reduce the state's contribution to global warming. But implementing the recommendations is a much bigger challenge.

This report focuses on six policies reviewed by the New England Climate Coalition for possible adoption in all New England states. These policies should be among Rhode Island's top priorities for reducing global warming emissions. Some of these strategies are already included in the stakeholders' *Greenhouse Gas Action Plan*; others are not. All, however, should be fully implemented. In doing so, Rhode Island will begin to reduce its emissions now and for decades to come.

Global Warming and Rhode Island

Global warming poses a clear danger to Rhode Island's future health, well-being and prosperity. The major greenhouse gas in Rhode Island is carbon dioxide, which comes from burning fossil fuels to run vehicles, and to heat and light buildings and facilities. Rhode Island'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 human exacerbation of the greenhouse effect. The greenhouse effect is 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 changed the atmosphere and intensified the greenhouse effect by trapping more of the sun's heat near the earth's surface. Since 1750, 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 concentration 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

Fig. 1. Atmospheric Concentrations of Greenhouse Gases[2]

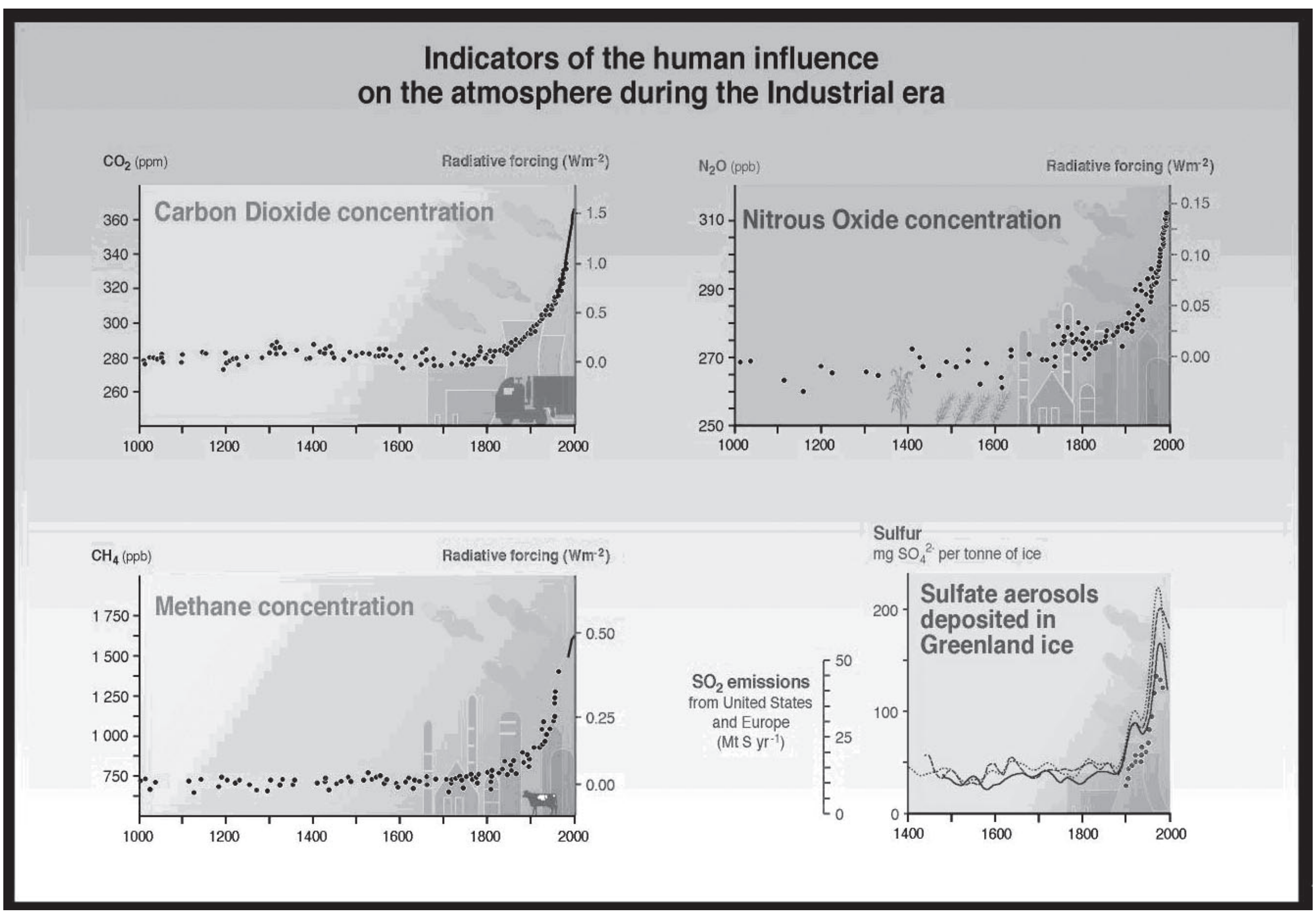
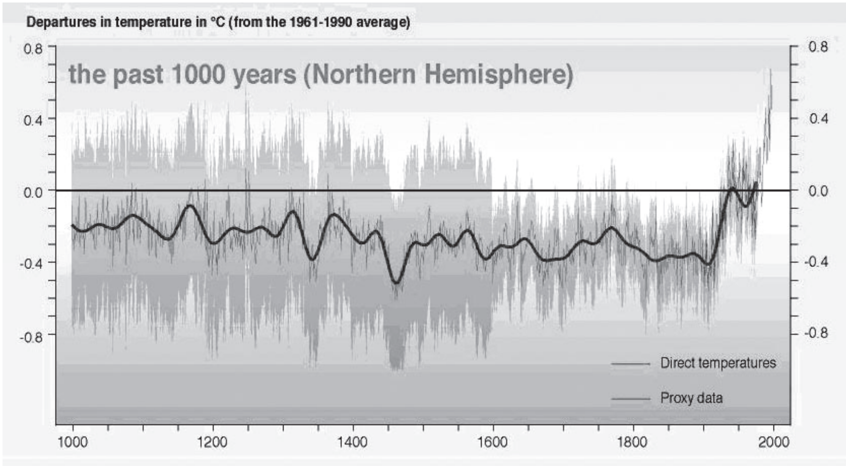


Fig. 2. Northern Hemisphere Temperature Trends[5]



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 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]

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 portion of the state's contribution to global warming.

- **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 vast majority of Rhode Island'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 describe 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 describe emissions in terms of "carbon dioxide equivalent." To translate the latter measure to carbon equivalent, multiply by 0.273.

Current Indications of Climate Change

Early symptoms of global warming are beginning to appear, both in Rhode Island and around the world. The Intergovernmental Panel on Climate Change, a broad group of scientists and researchers from around the world, concludes that "regional changes in climate, particularly increases in temperature, have already affected a diverse set of physical and biological systems in many parts of the world."[7]

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 Providence has increased by 3.3° F.[8] Statewide, average temperatures are estimated to have increased by 2.3° F between 1895 and 1999.[9] The average temperature of surface water in Narragansett Bay has risen 3° F since 1950.[10]

Precipitation patterns have changed. Precipitation has increased by 20 percent in Rhode Island.[11] Maine, New Hampshire, and Vermont, however, have experienced a 15 percent decrease in snowfall.[12] 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.[13]

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.[14] Glaciers around the world have been retreating.[15]

Oceans have risen as sea ice has melted. Average sea levels have risen 0.1 to 0.2 meters in the past century.[16]

Potential Impacts of Global Warming

The earth's climate system is extraordinarily complex, making the ultimate impacts of global warming in a particular location – as well as the pace of change – difficult to predict. There is little doubt, however, that global warming could lead to dramatic disruptions in the world's and Rhode Island's economy, environment, health 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.[17] In Rhode Island, temperatures could increase by 1° F to 10° F by 2100.[18] A 10° F increase in average temperature would give Rhode Island a climate similar to Atlanta, Georgia.[19] 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.[20] Precipitation levels also could change. Rhode Island could experience an increase in precipitation of 5 to 50 percent, with the greatest increase in winter.[21]

Perhaps more significantly, the number of extreme weather events – very hot days in summer and stronger, high-precipitation winter storms – could increase.[22]

The impacts of such a shift in average temperature and precipitation would be significant. Further, the increasing frequency of extreme weather could impose severe health damage. Among the potential impacts:[23]

- 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.
- Increased spread of exotic pests and shifts in forest species – including the loss of hardwood forests responsible for Rhode Island's vibrant fall foliage displays.
- 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. Narragansett Bay populations of winter flounder and sea robins, which prefer cold water, have already declined more than can be explained by fishing pressures.

- Increases in toxic algae blooms and "red tides," resulting in fish kills and contamination of shellfish.

- Declines in freshwater quality due to more severe storms, increased precipitation and intermittent drought, potentially leading to increases in waterborne disease.

- Increased coastal flooding due to higher sea levels, with sea levels projected to rise by as much as 30 inches over the next century. Rhode Island has over 400 miles of shoreline, much of it heavily populated and developed, that could be affected by rising sea levels.

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

- Increased risk of heat-related illnesses and deaths from intense heat waves – perhaps by as much as 50 percent, from 50 to 75 deaths annually.

- Disruption to traditional New England industries such as fall foliage-related tourism, maple syrup production, and agriculture.

Although the likelihood and severity of these potential impacts is difficult to predict, climate changes such as those predicted by the latest scientific research would have a dramatic, disruptive effect on Rhode Island'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 Rhode Island result from the combustion of fossil fuels. Fossil fuels are burned directly in homes, businesses, vehicles and industrial facilities to produce heat and to 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.

New England's economy is integrated across state lines, making it difficult to clearly assign responsibility for particular carbon dioxide emissions to each state. For example, Rhode Island draws its electricity from a New England-wide electric grid, which is supplied with power from across the region and beyond. Electricity generation emissions could be assigned to the state where the electricity is produced or to the state where the electricity is consumed.

In this report we have selected a third approach for dealing with electricity sector emissions. We will assess emissions from electricity generators at the regional level, not necessarily assigning the emissions to one specific state. On the other hand, emissions from residential, commercial and industrial direct fuel combustion will be considered at the state level.

Rhode Island's Direct Emissions (Non-Electric)

Carbon dioxide emissions from sources other than electricity generation increased in Rhode Island by approximately 9 percent from 1990 to 2000 – from 2,250 thousand metric tons carbon equivalent (MTCE) to 2,450 thousand MTCE.[4] (See Table 1.) This estimate does not include emissions from the use of electricity in

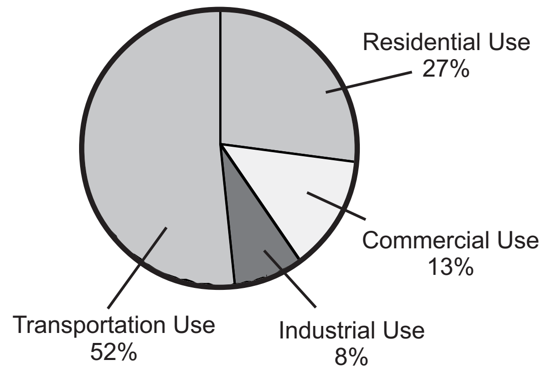
Table 1. Historic and Projected (Base Case) Rhode Island Non-Electric Carbon Dioxide Emissions (thousand MTCE)[25]

	1990	2000	*2010*	*2020*
Direct Emissions	2,250	2,450	*2,690*	*2,950*
Pct. Increase Over 1990		9%	*20%*	*31%*

any of the sectors. While emissions in the residential, commercial and transportation sectors increased significantly during the decade, industrial emissions declined, due to the shift from higher-emitting petroleum to lower-emitting natural gas in many industrial establishments and a slight decline in overall industrial energy use.

In 2000, the transportation sector was responsible for approximately 52 percent of Rhode Island's carbon dioxide emissions from sources other than electricity generation. The residential sector was responsible for about 27 percent of direct emissions, with the commercial sector responsible for 13 percent and the industrial sector for 8 percent. (See Fig. 3.)

Fig. 3. Rhode Island Direct (Non-Electric) 2000 Carbon Emissions by Sector

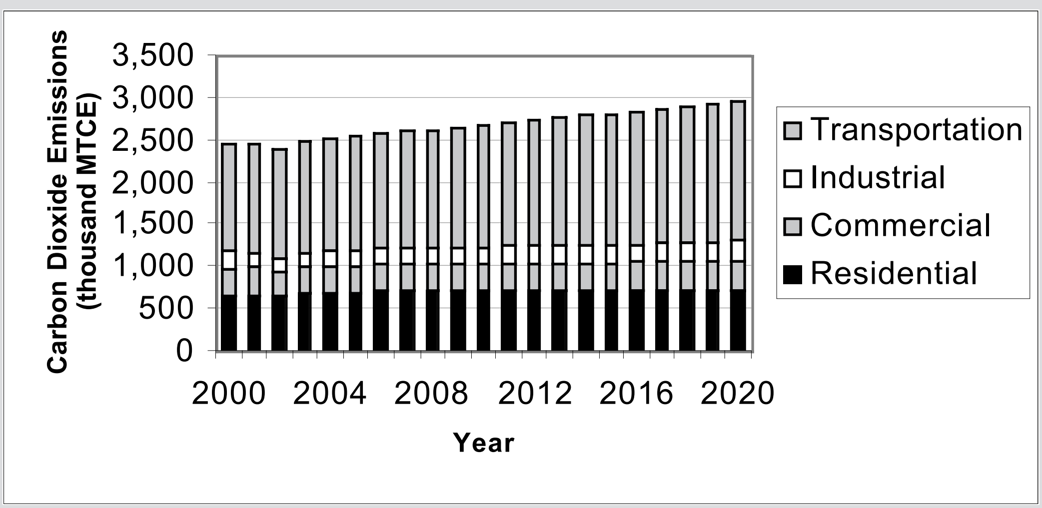


The U.S. Energy Information Administration (EIA) has projected rates of increase in energy use in New England from 2000 to 2020. Applying the EIA's projected New England rates of energy use increases (with an adjustment to reduce what appears to be an overestimate of future transportation gasoline use) to Rhode Island, and applying standard fuel-specific emission factors to those estimates, Rhode Island is projected to experience a 20 percent increase in direct carbon dioxide emissions from energy use between 2000 and 2020 in the absence of mitigating action.[26] Between 2000 and 2010, emissions from these sources could increase by about 240 thousand MTCE, with a further 260 thousand MTCE increase between 2010 and 2020. Most of the 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 5 percent – or 0.5 million metric tons carbon equivalent (MMTCE) – between 1990 and 2000. (See Table 2.) The relatively modest rate of growth in emissions is due largely to the shift from higher-polluting coal and petroleum to less-polluting natural gas.

Fig. 4. Rhode Island Projected (Base Case) Non-Electric Carbon Dioxide Emissions, 2000-2020



In Rhode Island, electricity use rose 14 percent from 1990 to 2000.[27] In contrast, in-state generation soared by over 700 percent. In 1990, Rhode Island generated very little of its own electricity, importing most from neighboring states. During the 1990s, however, new natural gas-fired generating capacity was built in Rhode Island, leading to increased electricity generation – and global warming emissions – within the state's borders. This change in Rhode Island – dramatically increased generation to serve the rest of New England but more limited growth of in-state consumption – is another argument for viewing global warming emissions from electricity generation and consumption through a regional lens.

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. 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 16.) 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 New England emissions of carbon dioxide versus a projection made based on the 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 4.4 MMTCE – between 2000 and 2020.[29] (See Fig. 5.)

Regional Responses

The threat posed by global warming has provoked a variety of responses in Rhode Island 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,

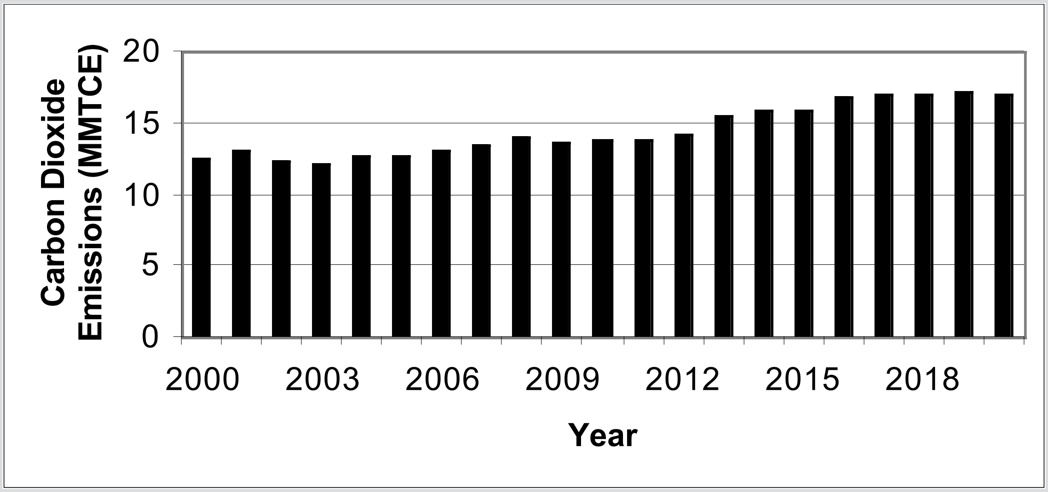
Table 2. Historic and Projected (Base Case) Electric Sector Carbon Dioxide Emissions in New England Without Nuclear Relicensing (MMTCE)[28]

	1990	2000	*2010*	*2020*
Electric Sector	12.0	12.6	*13.8*	*17.0*
Pct. Increase Over 1990		5%	*15%*	*42%*

Table 3. Summary of Historic and Projected Carbon Dioxide Emissions and Regional Goals (MMTCE)

	1990	2000	2010	2020
RHODE ISLAND'S DIRECT CARBON DIOXIDE EMISSIONS				
Historic/*Projected* Emissions	2.3	2.5	*2.7*	*2.9*
Regional Goal			2.3	2.0
Reductions Needed to Achieve Goal			0.44	0.92
NEW ENGLAND ELECTRIC SECTOR EMISSIONS				
Historic/*Projected* Emissions	12.0	12.6	*13.8*	*17.0*
Regional Goal			12.0	10.8
Reductions Needed to Achieve Goal			1.8	6.2

Fig. 5. Projected (Base Case) Carbon Dioxide Emissions from Electric Generation in New England (MMTCE)[30]



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.

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. (See Table 3.) In the long run, the plan aims to 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.[37]

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.[38] (See Fig. 6, page 17.) 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.

The Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP) is continuing to 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 policies to reduce transportation sector emissions and improve energy efficiency.

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 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.[31]

  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.[32] A 2003 General Accounting Office report found significant weaknesses in the Nuclear Regulatory Commission's oversight of security at commercial nuclear reactors.[33]

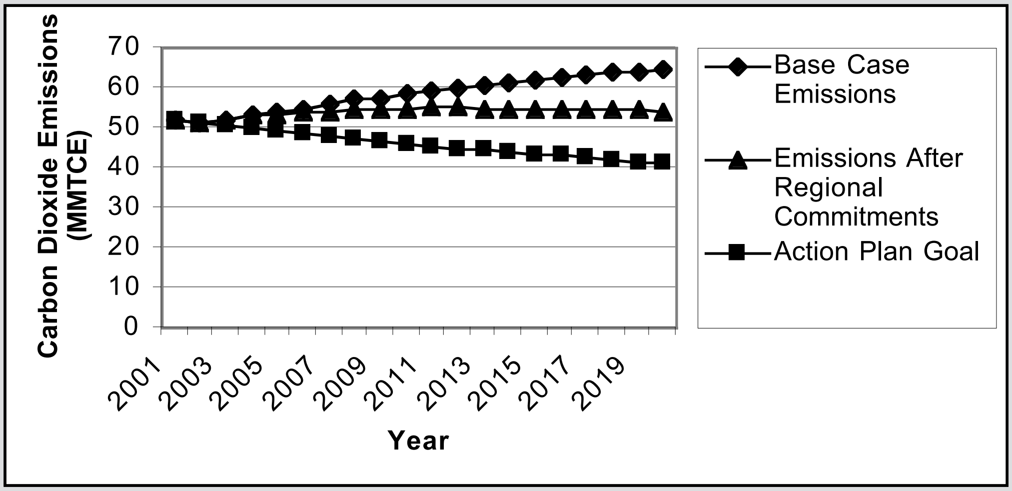
- **Spent fuel** – Nuclear power production results in the creation of tons of spent fuel, which must be stored either on-site or in a centralized repository. Both options pose safety problems. Centralized waste repositories require the transport of high-level nuclear waste across highways and rail lines in close proximity to 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 on site in water-filled pools at densities approaching those in reactor cores. Should coolant from the spent-fuel pools be lost, the fuel could ignite, spreading radioactive material across a large area. The cost of such a disaster, were it to occur, has been estimated at 54,000-143,000 deaths from cancer and evacuation costs of more than $100 billion.[34]

- **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.[35] 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 just the previous 17 months in which nuclear reactors were forced to shut down due to age-related equipment failures.[36]

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.

Fig. 6. Carbon Dioxide Emission Reductions in New England Under Implementation of Regional Climate Change Action Plan[39]



Rhode Island Greenhouse Gas Stakeholder Process

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.

Rhode Island began this process in the fall of 2001. The Rhode Island Department of Environmental Management and the State Energy Office convened the Rhode Island Greenhouse Gas Stakeholder Process, which includes representatives from government agencies, business and industry interests, citizen groups, and environmental organizations. In Phase I, the stakeholders reviewed and prioritized a list of global warming emission reduction measures. The recommendations from Phase I were released in July 2002 as the *Rhode Island Greenhouse Gas Action Plan*.[40] The action plan includes 52 policies. By the group's analysis, implementation of the 49 in-state policy options will allow the state to meet the regional 2020 emissions-reduction target. Further savings can be achieved through policies that involve regional or national coordination.

The 52 policy options fall into five areas: transportation, land use, energy supply, buildings and facilities, and solid waste. Some of the policies involve the continuation or expansion of current programs, while others are new programs.

For the transportation sector, the policies strive to reduce per-mile global warming emissions from motor vehicles with policies such as a "feebate" program, under which fees would be assessed on the sale of cars with high carbon dioxide emissions and rebates extended to purchasers of low-carbon vehicles, thus promoting the purchase of low-carbon vehicles. Another set of measures aims to reduce the growth of vehicle travel in Rhode Island by improving transit, expanding walking and bicycling options, and encouraging alternatives to commuting.

How land is used can directly reduce or add to Rhode Island's global warming emissions. The stakeholders' land use recommendations included policies for minimizing carbon releases from land and maximizing the amount of carbon that Rhode Island's forests, fields, and wetlands absorb.

The stakeholders' energy supply policies focus on reducing the amount of global warming gases released per unit of electricity generated. One program they recommended and which the state has adopted was a renewable portfolio standard, which establishes a minimum percentage of retail electricity sold to Rhode Island consumers that has to come from low- or zero-emission sources. On a regional level, the stakeholders recommended adoption of a carbon cap on emissions from the electricity sector that would encourage power producers to close high-emission coal- or oil-fired generation plants and replace them with lower-emission sources such as natural gas plants or zero-emission renewable energy. (Rhode Island is already participating in a regional effort to establish carbon caps on power plants.)

The buildings and facilities recommendations seek to cut carbon emissions by reducing the consumption of energy. Strategies to reduce emissions from buildings focus on attaining the highest energy efficiency for new buildings and equipment, retrofitting existing structures to maximize efficiency, and replacing older, less-energy efficient equipment. These changes reduce consumption of electricity, natural gas, and heating oil, reducing global warming emissions and potentially saving money for consumers.

Waste management produces global warming emissions: methane and carbon dioxide leak from landfills, and waste combustion releases carbon dioxide and nitrous oxide. The stakeholders recommended several policies to reduce the amount of trash, and resultant emissions, in Rhode Island. One policy change would allow trash haulers and non-residential waste generators to share the financial benefits of reducing waste. Another policy would establish a per-unit charge for trash disposal, giving consumers incentives to reduce the quantity of waste they produce.

Since producing their recommendations, the stakeholders have engaged in further research and development of implementation strategies for the higher priority options. The next steps will involve actual program implementation of the high priority options and the development of implementation plans for the other options.

Even before beginning the stakeholder planning process, Rhode Island had adopted several policies to reduce the state's energy use, and thus its emissions of global warming gases. Rhode Island requires that state government agencies purchase energy-efficient office equipment. All new buildings under construction in the state must conform to building codes that reduce energy use and thus emissions.

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 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 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) **Reducing emissions from the electricity sector as a whole by 40 percent from current levels.** Every state 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.**

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.

These principles provide a yardstick against which to measure the policy options proposed by the stakeholders, those advocated in this report and elsewhere.

Priority Emission-Reduction Policies for Rhode Island

Rhode Island has the tools for reducing its greenhouse gas pollution. It now needs to begin using them.

The six policies highlighted below are high-result strategies that, if adopted, could provide the first significant reductions in Rhode Island's global warming emissions. Their implementation should be followed by the adoption of the broad range of policies included in the *Rhode Island Greenhouse Gas Action Plan*.

Reducing Emissions from the Transportation Sector

The transportation sector poses the greatest challenge for Rhode Island as it seeks to reduce its emissions of global warming gases. Not only is transportation Rhode Island's largest source of carbon dioxide emissions – responsible for about 52 percent of total in-state non-electric emissions in 2000 – but it is also among the fastest-growing sources. Transportation-sector carbon dioxide emissions increased by 13 percent in Rhode Island between 1990 and 2000, and could increase by an additional 30 percent between 2000 and 2020 if trends toward increasing vehicle travel continue.[41]

Light-duty vehicles are by far the largest source of transportation-sector carbon dioxide emissions, responsible for about two-thirds of transportation emissions in Rhode Island.[42] 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: switch to low-carbon fuels, improve fuel economy, and reduce vehicle travel. To achieve the kinds of reductions needed to meet Rhode Island's commitments, the state will have to make progress in all three areas. The three transportation-sector policies recommended below for rapid implementation cover each approach.

The near-term adoption of these and other transportation-related strategies is crucial because it will take time for them to have a major impact. First, the spread of widely dispersed suburban development in Rhode Island since World War II has created dependence on the automobile for many daily tasks. Adjusting land-use patterns to allow for the effective provision of transit service and the creation of other transportation alternatives in these communities is a long-term endeavor.

Second, transportation technologies often have a long lifespan. The average car or SUV sold in Rhode Island in 2004, for example, will likely remain on the road for the next 12 to 15 years. As a result, technological advances that improve fuel economy or reduce emissions often take a long time to percolate through entire vehicle fleets.

Thus, any delay in adoption of these measures will result in more high-carbon vehicles traveling Rhode Island's highways for years to come.

Strategy #1: Finalize and Implement A Clean Cars Requirement

Potential Savings: 6.0 thousand MTCE by 2010; 32 thousand MTCE by 2020.[43]

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 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.

Under Governor Carcieri's leadership, Rhode Island recently moved to adopt California's emission standards for automobiles. Because the Clean Air Act requires states choosing California standards to give manufacturers two years of lead time prior to enforcement, Rhode Island must formally adopt the program's specific rules this year in order to begin implementation in 2007. Otherwise, the standards will be delayed, meaning that Rhode Island will wait longer 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 will be required to sell the equivalent of several thousand hybrid vehicles per year in Rhode Island, with the numbers increasing over time. Then, beginning in 2012, automakers will 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 Rhode Island would be hybrids, while about 3 percent would be hydrogen fuel-cell or other vehicles with zero emissions. [44]

In the near term, the ZEV program will place thousands of hybrid-electric vehicles on Rhode Island's highways. Hybrids – such as the Toyota Prius, Honda Civic, and Ford Escape – 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 Rhode Island and elsewhere. About 43,000 hybrids were sold in the U.S. in 2003, an increase of 26 percent from the previous year, and sales are expected to exceed 177,000 by 2005.[45] 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 Rhode Island residents a broader choice of cleaner vehicles. In addition, the ZEV programs in Rhode Island 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) can help Rhode Island consumers to afford hybrid vehicles, which typically cost about $3,000-$4,000 more than similar non-hybrid models.

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.[46] 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, Rhode Island can anticipate about a 3 percent reduction in emissions from light-duty vehicles compared to the 2020 base case as a result of fully implementing the ZEV program.[47]

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

Potential Savings (Including Savings from ZEV Program): 8.8 thousand MTCE by 2010, 96 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.[48] 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, and other states would have the ability to adopt the California standards.

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 final regulations implementing the law have not yet been developed.

In estimating the benefits of the Pavley standards, we conservatively 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 projected here.[49]

Rhode Island will have the opportunity to make better estimates of the impact of the program when the California regulations are issued in 2005.

In the meantime, Rhode Island can lay the groundwork for the Pavley standards by implementing the 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 strategies to reduce automotive carbon emissions at the federal level.

Strategy #3: Implement Pay-As-You-Drive Automobile Insurance

Projected Savings: 54 thousand MTCE by 2010; 59 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.[50] Many insurers do provide low-mileage discounts to drivers, but these discounts are often small, and do not change 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 system of insurance in Rhode Island 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. One option is to have vehicle owners include their most recent odometer reading when renewing their insurance, and to conduct random spot checks to encourage truthful reporting. Alternatively, odometer audits could be performed by a certified company at a low financial and time cost per vehicle.[51]

A pay-as-you-drive (PAYD) system of insurance would have great benefits for Rhode Island – 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 – particularly in a state with high auto insurance rates such as Rhode Island. Converting the average collision and liability insurance policies to a per-mile basis in Rhode Island would lead to an average insurance charge of about 10 cents per mile.[52] (By contrast, a driver of a 20 MPG car buying gasoline at $1.50 per gallon – far below current prices – pays only 7.5 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 7.6 cents per mile in Rhode Island) would reduce vehicle-miles traveled by about 11.2 percent, with carbon dioxide emissions from light-duty vehicles declining by roughly the same amount.[53] Should one-half of Rhode Island drivers be covered by the PAYD option, light-duty VMT – and, therefore, light-duty vehicle carbon dioxide emissions – could be reduced by 5.6 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.[54]

The stakeholders reviewed the possibility of adopting mileage-based insurance. Though the group recognized the benefits of PAYD insurance, they did not recommend its inclusion in the *Greenhouse Gas Action Plan*. Instead they recommended further study and reconsideration after another state – such as Massachusetts, which has studied the feasibility of adopting PAYD – adopts some form of mileage-based insurance.[55] The stakeholders estimated that PAYD insurance would apply to all drivers in the state and therefore would reduce emissions by 110 thousand MTCE (compared to our estimated savings of 59 thousand MTCE if half of the state's drivers participate).

Rhode Island should step into the lead and introduce PAYD insurance 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 implemented in Rhode Island.

Policy Alternative: Pay-At-The-Pump Insurance

A close relative of pay-as-you-drive insurance, pay-at-the-pump policies would require the state to collect a surcharge on gasoline sales that would then provide minimal insurance coverage to drivers. Drivers would still purchase additional insurance coverage in the traditional manner.

Pay-at-the-pump systems have several advantages. First, they do not require verification of odometer readings. Second, as a global warming measure, they tie insurance coverage to the amount of fuel used – encouraging both reductions in vehicle travel and the purchase of more efficient vehicles. Third, drivers of larger, less fuel-efficient vehicles (such as large SUVs) impose greater costs when they get into accidents. Evidence shows that SUVs and other large vehicles are more likely to kill or severely injure occupants of other vehicles in a collision and that the sense of security provided by driving in a large vehicle may lead to more dangerous driving behaviors.[56] To the extent this is true, pay-at-the-pump can put a price on the additional risk these vehicles pose. Finally, pay-at-the-pump can generate a pool of funds to cover uninsured motorists, thereby reducing premiums for insured motorists who currently carry the financial burden of those who are not insured.

Reducing Emissions from Electricity Generation

Rhode Island can reduce carbon dioxide emissions from electricity through two methods: by reducing global warming emissions from each unit of electricity generated, whether in Rhode Island or elsewhere in New England, and by consuming less electricity. Cleaning up the New England electric grid can be achieved by encouraging a shift away from carbon-intensive fuels such as coal and oil and toward renewable energy sources such as solar and wind. Regional cooperation on this matter is crucial, since current generation capacity and renewable resources are not distributed evenly across the six New England states. (Policies that reduce electricity consumption are discussed in the next section.)

Strategy #4: Implement a Strong Renewable Portfolio Standard

Potential Savings: 100-240 thousand MTCE by 2010; 220-530 thousand MTCE by 2020.

More than a dozen states around the country, including three New England states – Massachusetts, Maine, and Connecticut – 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 sold by utilities be generated from renewable energy sources. 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.

In June, the Rhode Island Legislature unanimously passed and Governor Carcieri signed legislation adopting an RPS for the state. Now, Rhode Island should work toward prompt and thorough implementation of the provisions of the RPS to spur the greatest development of new renewables.

Rhode Island currently consumes almost no electricity from clean renewable sources. Most of the state's power comes from coal, natural gas, and nuclear plants. Beginning in 2007, the state's RPS requires that three percent of electricity come from renewable sources. The amount increases over time, reaching 4.5 percent in 2010 and 16 percent in 2020.[57] The electricity does not have to be generated within Rhode Island; it can come from anywhere within New England. If a utility fails to meet the RPS requirement in a given year, it has to make a payment to a trust fund managed by the state. The money in that fund can be used to enter long-term contracts with renewable energy suppliers, giving builders reassurance that their investment in new facilities will pay off; the lack of long-term contracts currently is a major obstacle to development of new renewable resources.

The Rhode Island stakeholders, in their *Greenhouse Gas Action Plan*, endorsed adopting an RPS that increases generation from new renewable power sources by 20 percent by 2020.[58] If 10 percent of electricity consumed in Rhode Island in 2010 were produced by new renewables and 20 percent by 2020, Rhode Island would achieve savings of 100-240 thousand MTCE by 2010 and 220-530 thousand MTCE by 2020. The higher near-term estimate is based on adoption of a strong regional carbon cap that allows reductions in electricity consumption and increases in renewable generation to offset generation from coal-fired power plants. (Projecting the estimated benefits of a national RPS to Rhode Island, the stakeholders estimated that such a policy would save 140 thousand MTCE in 2020.[59])

These estimated savings are higher than those likely to be achieved by the recently adopted RPS since the version of an RPS modeled in this report and by the stakeholders is implemented more quickly and reaches a higher target in 2020. Still, the state's RPS represents a very important step toward the increased development of clean energy sources in the state and region.

If an RPS achieving 20 percent of electricity from new renewable energy by 2020 were applied to all power generated 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.

This level of renewable power production in New England is 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.[60] Technological improvements in the future could allow the cost-effective generation of additional power from wind. This estimate does not include the wind energy that could be harnessed by offshore wind turbines, which potentially could supply more electricity each year in New England than the region currently consumes.[61]

In sum, fulfilling a 20 percent renewable portfolio standard for New England would require the development of less than two-thirds of the region's onshore wind potential under even the most conservative estimates, without factoring in the potential for technological improvements to make wind power feasible for distributed applications and at lower wind speeds. Adding solar, landfill gas, and clean biomass (that which does not contribute to toxic air emissions) to 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.[62]

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, perhaps similar to the requirements Rhode Island is considering. 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 combined heat-and-power, that improve efficiency but do not draw on truly renewable resources.

The need for regional standards is particularly important because any RPS will necessarily 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. One such example is Massachusetts' RPS, which allows the fulfillment of requirements through the development of renewables in other New England states or even outside the region.

Rhode Island should implement its RPS guidelines to ensure the greatest development of new renewable power capacity. 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.

Reducing Emissions from Homes, Business and Industry

The residential, commercial and industrial sectors are responsible for about half of Rhode Island's non-electric emissions of carbon dioxide. Emissions can be cut by reducing the amount of global warming pollution produced during the generation of electricity (as discussed in the previous section on "Reducing Emissions from Electricity Generation") and by improving the efficiency of electricity and fossil fuel consumption used to heat and light buildings and to operate appliances.

Appliances and buildings remain in use for years. Efficiency improvements adopted now will yield immediate benefits and will also produce emissions savings over the lifetime of the relevant appliance or structure. Raising efficiency standards soon will hasten their penetration of the market and add to the cumulative benefits.

Strategy #5: Adopt Appliance Efficiency Standards

Potential Savings: 29-63 thousand MTCE by 2010; 84-180 thousand MTCE by 2020.

Household appliances and those used by business 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.[63]

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.

Although states are pre-empted from adopting their own efficiency standards for products covered by federal standards, 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.[64] (See Table 4.) The NEEP study estimated that adoption of this package of appliance standards would bring Rhode Island approximately $338 million in net economic benefit by 2020.[65]

In estimating the carbon dioxide reductions that would result from stronger appliance efficiency standards 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 lower if it is assumed that electricity savings reduce the need for the construction of new gas-fired power plants, and higher 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 box on page 28.)

The Rhode Island stakeholder group included upgrading and extending appliance efficiency standards in the *Greenhouse Gas Action Plan*. They estimated that in 2020 a policy that required higher efficiency from 15 to 30 appliances would save 100 thousand MTCE of emissions.[67] This is within the range of savings we estimated from higher standards on 16 appliances.

Table 4. Products Covered Under Proposed Efficiency Standards[66]

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

Maryland adopted efficiency standards in early 2004 for nine types of appliances that will decrease electricity use by 1,300 gigawatt-hours (enough power for 150,000 typical households) and will save consumers $600 million through 2020.[68] As a result of Maryland's leadership on this issue, several other states in the Mid-Atlantic region – including Pennsylvania and New Jersey – are now considering similar standards. Connecticut recently adopted similar standards as well.

Rhode Island 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 #6: Expand Energy Efficiency Programs

Potential Savings: 87-120 thousand MTCE by 2010; 200-290 thousand MTCE by 2020.

Improved appliance efficiency standards, while important, are limited in their scope, leaving many sources of energy use untouched. Broad energy efficiency measures can reduce energy use – and emissions – from existing fixtures and buildings.

There are many barriers to the adoption 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 will lower costs in the long run, consumers may resist paying more up front for purchasing an energy efficient building or piece of equipment. In some cases, consumers may not be able to afford the initial investment in energy efficiency, regardless of its long-term benefits.

Traditionally, states have required electric utilities to make investments in efficiency programs through the rate-setting process. In some states that have deregulated their electric industries - including Rhode Island – a new means of financing efficiency improvements has been created by assessing 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 energy security) and 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.

Reducing Electric Sector Emissions Through a Regional Carbon Cap

A regional cap-and-trade system for electricity-generating facilities provides an opportunity to dramatically cut carbon emissions. It would allow the region 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. The magnitude of the emissions savings that can be achieved with a carbon cap are reflected in the range of potential savings from electricity-related policies discussed in this report. A regional carbon cap will amplify the effect of other greenhouse gas policies Rhode Island may adopt.

Rhode Island is currently working with nine other northeastern states, from Maine 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 Rhode Island stakeholder group recommends the adoption of a regional carbon cap for the power sector.

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. Developers of carbon caps must grapple with several important issues, including the following:

- **Cap Levels** – The program must establish a target for the total amount of carbon that can be released. This target should be set at a level that will achieve the goals of the regional accord.

- **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, the New England states should be moving toward a phase-out of nuclear generating capacity, and should not allow nuclear power to qualify as an offset under any cap-and-trade program.

  The use of offsets as a method of compliance with the carbon cap produces other potential problems. Massachusetts's rule for its electric sector carbon dioxide emission cap, for example, requires that any offsets provide "real, surplus, verifiable, permanent and enforceable" emission reductions.[69] Practically speaking, however, designing offsets that meet these criteria is extraordinarily difficult.

  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 Rhode Island 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 addition, 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. Rhode Island can 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 program.

Rhode Island established its SBCs through electric restructuring legislation adopted in 1996.[70] SBCs are assessed in Rhode Island to support energy efficiency programs and the development of renewable energy sources.

The efficiency SBC rate is 2.1 mills ($0.0021) per kilowatt-hour.[71] Rhode Island's electricity efficiency programs are implemented by the state's electricity distributor, Narragansett Electric Company, which serves nearly all the state's residential, commercial, and industrial customers. Narragansett Electric reported that improvements made through its efficiency programs in 2002 will save approximately 700 gigawatt-hours (GWh) of electricity over the lifetime of the measures (a savings rate of about 3.1 kilowatt-hours annually per dollar spent, which will lead to lifetime economic savings of about $43 million).[72] SBC funds support a wide variety of efficiency-related programs, including: technical and design assistance; rebates to promote efficiency in new commercial construction; rebates for the purchase of efficient lights, appliances, and heating in homes; low-interest loans for home weatherization; and other programs.[73] (The Pascoag Utility District, which provides service to less than one percent of Rhode Island's residential electricity users, operates similar energy conservation programs.[74])

Should Rhode Island 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), Rhode Island could still achieve carbon savings of 65-150 thousand MTCE by 2020.

The impact of a gas and oil SBC program is more difficult to predict, but it would be substantial. 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 of saving 1,000 cubic feet of natural gas was $29.[75] Assuming that a gas and oil SBC-type program applied to residential, commercial and industrial consumption in Rhode Island would achieve a savings rate 75 percent of that experienced in Vermont, an SBC of 3.5 cents per 100,000 BTU of energy consumed would reduce Rhode Island's carbon dioxide emissions by approximately 140 thousand MTCE by 2020. An SBC at this rate would translate into a rate of about 3.5 cents per therm of natural gas or 2.5 cents per gallon of distillate heating oil.

The Rhode Island greenhouse gas stakeholders recommended expanding existing electricity, oil, and gas efficiency programs and adding new ones. Electric efficiency policies include retrofitting residential heating and cooling systems, lighting and appliances, and retrofitting non-residential facilities to reduce electricity consumption. These and other electricity efficiency programs would save approximately 60 thousand MTCE in 2020.

Natural gas and oil efficiency programs include retrofitting commercial and industrial facilities to reduce fossil use and promoting the purchase of efficient fossil fuel furnaces in homes. The stakeholders estimated these conservation measures would save 131 thousand MTCE in 2020.[76]

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.

The Impact of the Strategies

Short- and Medium-Term Impacts

Implementing the six strategies listed above will begin to reduce Rhode Island's global warming emissions. More importantly, they will put Rhode Island on solid footing to pursue other carbon-reduction policies.

Implementing these first six strategies will reduce Rhode Island's direct (non-electric) releases of carbon dioxide by nearly 300 thousand MTCE in 2020, slightly less than one third of the 920 thousand MTCE reductions Rhode Island needs to achieve to meet the regional goal for 2020. (See Table 5, page 30.) Electric sector emissions, which are expected to rise significantly in the absence of any mitigating measures, would be reduced by 860 thousand MTCE in 2020, an amount greater than Rhode Island's total electric sector emissions in 2000.

While these emission reductions are valuable, the true importance of adopting these six policies lies in the foundation they create for further change in Rhode Island. The strategies demonstrate that cutting global warming emissions can be straightforward, improve air quality through reducing emissions of other health-threatening pollutants, and benefit consumers. By taking these first concrete actions to cut its carbon emissions, Rhode Island will both reduce its emissions and build a foundation from which to begin adopting all the policies of the *Greenhouse Gas Action Plan*.

And finally, by adopting these policies Rhode Island can set an example for other states to follow.

Table 5. Projected Annual Carbon Dioxide Emission Reductions from Policies (thousand MTCE)

Policy	2010	2020
Clean Cars Requirement	6.0	32
Carbon Dioxide Tailpipe Standards	8.8	96
Pay-As-You-Drive Auto Insurance	54	59
Renewable Portfolio Standard	100-240	220-530
Appliance Efficiency Standards	29-63	84-180
Expanded Energy Efficiency Programs	87-120	200-290
Total Direct (Non-Electric) Reductions	130	300
Total Electric Sector Reductions	160-370	360-860

Putting It in Perspective – Achieving the Long-Term Goal

Ultimately, Rhode Island'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.

The six strategies above would, if implemented, not only move Rhode Island 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 thousands of high-efficiency and zero-emission vehicles on Rhode Island's roads, while focusing the research energy of automakers on the development of the next generation of clean automobile technologies. The California vehicle carbon emissions program, if properly designed and implemented, will create the regulatory framework to ensure that all vehicles make the least possible impact on the climate. 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 one-fifth of the electricity Rhode Island 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, Rhode Island 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 Rhode Island will have to do their share as well.

Affecting these changes will require further research and discussion, and an unprecedented amount of 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: Rhode Island and the other New England states are now engaged in the discussion and study of global warming, and Rhode Island, through the efforts of the stakeholder group, has already identified what it needs to do to achieve the interim goals. But the critical test – implementation – lies ahead.

By using existing technologies and reasonable public policy tools, Rhode Island 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.

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 Rhode Island. Future emission trends in Rhode Island are generally based on EIA's projected rates of growth for New England as a whole. Rhode Island trends will differ, but the EIA growth projections provide a reasonable approximation of future trends, particularly given the regional context of Rhode Island'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 Rhode Island (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 Rhode Island 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 estimated by multiplying utility consumption of coal in short tons from EIA, *Electric Power Annual 2001, Consumption by State* by the appropriate heat rate for Rhode Island, 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 Massachusetts in million cubic feet were obtained from EIA, *Rhode Island Natural Gas Consumption by End Use*, downloaded from http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_sri_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*, *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 operation of the region's nuclear power plants 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 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 Rhode Island are based on applying the New England year-to-year projected growth rates for each fuel in each sector from *AEO 2003* to the Rhode Island baseline emissions estimate for 2000, with two exceptions.

1) In the transportation sector, EIA's estimates of vehicle travel increases are significantly higher than recent growth rates. Instead of using EIA's projected growth rates for motor gasoline use, we used a growth rate of .08 percent per year, based on the historic VMT growth rate from 1990 to 2002 as reported by FHWA, *Highway Statistics* and applied to a 2000 VMT baseline. 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 base case estimate for power-sector energy use in New England was adjusted by eliminating generation from nuclear power plants as their licenses expire in 2012 and 2015 and replacing it 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, rather than retire less-efficient old generators.

- **High savings estimate** – Based on the use of efficiency savings and renewables 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 reductions possible under a regional carbon cap, since some 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 benefits 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 Rhode Island.

- **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 manufacturer-installed 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 Rhode Island 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 Rhode Island 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.

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 Rhode Island 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 Rhode Island 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 Rhode Island 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 7.6 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 www.vtpi.org/tdm/tdm79.htm, 3 December 2003). It was assumed that the decrease in VMT (11.2 percent) for drivers participating in the program would take place beginning immediately upon program implementation in 2005.

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.

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

Rhode Island 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.

Residential, Commercial and Industrial Strategies

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.[77] (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 Rhode Island. 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.

Notes

1. Working Group I, Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report – Climate Change 2001: Summary for Policy Makers*, *The Scientific Basis,* 2001.

2. Ibid.

3. Ibid.

4. Ibid.

5. Ibid.

6. Based on 1990 figures from U.S. Environmental Protection Agency, *State GHG Inventories*, downloaded from http://yosemite.epa.gov/OAR/globalwarming.nsf/content/EmissionsStateGHGInventories.html, 7 July 2003.

7. Working Group II, Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report – Climate Change 2001: Summary for Policy Makers*, *Impacts, Adaptation, and Vulnerability,* 2001.

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

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.

10. *Forestry, Land Use, and Climate Change: Strategies for Rhode Island*, presentation at workshop of Rhode Island Greenhouse Gas Process, 1 June 2004.

11. See note 8.

12. See note 9.

13. See note 1.

14. Ibid.

15. Ibid.

16. Ibid.

17. Ibid.

18. See note 8.

19. See note 10.

20. See note 9.

21. See note 8.

22. Ibid.

23. Impacts from U.S. Environmental Protection Agency, *Global Warming-State Impacts: Rhode Island*, Office of Policy, Planning, and Evaluation, September 1997; 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. Fish population change from "Scientists Track Warming Water," *Narragansett Bay Almanac*, Summer 2002.

24. 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. Note that these emissions figures are not directly comparable to those included in the *Rhode Island Greenhouse Gas Action Plan* due to different assumptions. See "Methodology and Technical Discussion" for more information on sources and methods for calculating carbon dioxide emissions from the fuel use data.

25. 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.

26. 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.

27. 14 percent increase in consumption in Rhode Island based on increase in sales of electric power from 1990 to 2000 from U.S. Energy Information Administration, *Electric Power Annual 2001 Spreadsheets, 1990 - 2001 Retail Sales of Electricity by State by Sector by Provider*, March 2003.

28. 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.

29. Based on 2000 fuel use data from U.S. Energy Information Administration *State Energy Data 2000* and other EIA reports and year-to-year projected rates of increase in energy consumption from EIA, *Annual Energy Outlook 2003*, 9 January 2003.

30. See note 9.

31. Swiss Agency for Development and Cooperation, *Chernobyl.info*, downloaded 20 January 2004.

32. Union of Concerned Scientists, Nuclear Reactor Security, downloaded from www.ucsusa.org/clean_energy/nuclear_safety/page.cfm?pageID=176, 24 July 2003.

33. U.S. General Accounting Office, *Nuclear Regulatory Commission: Oversight of Security at Commercial Nuclear Power Plants Needs to Be Strengthened*, September 2003.

34. Robert Alvarez, Jan Beyea, et al, "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States," *Science and Global Security*, 2003, 11:1-51.

35. Cumulative subsidies for nuclear power over the period 1947-1999 have been estimated at $145.4 billion, based on Marshall Goldberg, Renewable Energy Policy Project, *Federal Energy Subsidies: Not All Technologies Are Created Equal*, July 2000.

36. David Lochbaum, Union of Concerned Scientists, testimony before the Clean Air, Wetlands, Private Property and Nuclear Safety Subcommittee of the U.S. Senate Committee on Environment and Public Works, 8 May 2001, downloaded from www.ucsusa.org/clean_energy/nuclear_safety/page.cfm?pageID=191.

37. Conference of New England Governors/Eastern Canadian Premiers, *Climate Change Action Plan 2001*, August 2001.

38. New England Climate Coalition, *Global Warming in New England*, September 2003.

39. 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.

40. Rhode Island Greenhouse Gas Stakeholder Process, *Rhode Island Greenhouse Gas Action Plan*, 15 July 2002.

41. Increase from 1990 to 2000 is based on 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 Rhode Island from 1990-2002 from FHWA, *Highway Statistics*, applied to a 2000 VMT baseline.

42. To be more precise, motor gasoline combustion accounted for 75 percent of carbon dioxide emissions from transportation in Rhode Island 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.*)

43. Note that emissions savings projected here from a clean cars requirement and other policies cannot be directly compared to the savings projected from similar policies in the *Rhode Island Greenhouse Gas Action Plan* due to different baselines and assumptions about how the programs would be implemented.

44. 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.

45. John Porretto, "High Fuel Prices Pumping Up Hybrid Sales," *Associated Press,* 9 May 2004; J.D. Power and Associates, *J.D. Power and Associates Reports: Anticipated Higher Costs for Hybrid Electric Vehicles Are Lowering Sales Expectations* [press release], 27 October 2003.

46. Based on default values from Michael Wang, Argonne National Laboratory, Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) model, version 1.5a, 21 April 2001. Note: All figures for hybrids and conventional vehicles are based on emissions from vehicle operations (i.e. the tailpipe). Because hydrogen fuel cell vehicles have no tailpipe emissions, fuel-cycle emissions were used. The default energy efficiency of hybrid-electric vehicles in GREET 1.5a is assumed to be 90 percent greater than gasoline-powered vehicles operating on conventional gasoline, while the efficiency of fuel-cell vehicles is assumed to be 200 percent greater. A draft version of an updated GREET model (GREET 1.6) assumes smaller efficiency improvements from the two technologies.

47. These results are similar to the 2.25 percent reduction in carbon dioxide emissions in Massachusetts and Vermont 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.

48. California Assembly Bill 1493, adopted 29 July 2002.

49. California Environmental Protection Agency, Air Resources Board, *Draft Staff Proposal Regarding the Maximum Feasible and Cost-Effective Reduction of Greenhouse Gas Emissions from Motor Vehicles*, 14 June 2004.

50. For a summary of data demonstrating the link between increased vehicle travel and accident risk, see Victoria Transport Policy Institute, *Online TDM Encyclopedia: Pay-As-You-Drive Vehicle Insurance*, downloaded from www.vtpi.org/tdm/tdm79.htm, 4 December 2003.

51. Victoria Transport Policy Institute, *Online TDM Encyclopedia: Pay-As-You-Drive Vehicle Insurance*, downloaded from www.vtpi.org/tdm/tdm79.htm, 4 December 2003.

52. Based on Insurance Information Institute, *Facts and Statistics: The Rising Cost of Auto Insurance*, downloaded from www.iii.org/media/facts/statsbyissue/auto/content.print/, 29 October 2003. Not all Rhode Island drivers must purchase collision insurance, a fact that may slightly reduce average insurance rates in the states compared to the average rate this figure is based on.

53. Victoria Transport Policy Institute, *Online TDM Encyclopedia*, downloaded from www.vtpi.org/tdm/tdm79.htm, 2 January 2004.

54. Ibid.

55. Rhode Island Greenhouse Gas Stakeholder Process, *Rhode Island Greenhouse Gas Action Plan*, 15 July 2002.

56. Michelle J. White, *The "Arms Race" on American Roads: The Effect of SUVs and Pickup Trucks on Traffic Safety*, [unpublished].

57. *An Act Relating to Public Utilities and Carriers – Renewable Energy Standard*, passed by Rhode Island General Assembly 23 June 2004.

58. Rhode Island Greenhouse Gas Stakeholder Process, *Rhode Island Greenhouse Gas Action Plan*, *Phase I Report Appendices*, 15 July 2002.

59. The stakeholders' estimate of carbon savings from an RPS is lower than ours because of different assumptions, such as which types of generation are eligible and what existing or new generating facilities are displaced.

60. Energy Efficiency and Renewable Energy, U.S. Department of Energy, state by state *Wind Resources* estimates for all six New England states, downloaded from www.eere.energy.gov/state_energy, 23 November 2003.

61. Kevin J. Smith and George Hagerman, *The Potential for Offshore Wind Energy Development in the United States*, Proceedings of the 2nd International Workshop on Transmission Networks for Offshore Wind Farms, Royal Institute of Technology, Stockholm, 2001.

62. Massachusetts Division of Energy Resources, *RPS-Quali-*

fied New Renewable Generation Units, downloaded from www.state.ma.us/doer/rps/approved.htm, 5 December 2003.

63. Ned Raynolds and Andrew Delaski, Northeast Energy Efficiency Partnerships, *Energy Efficiency Standards: A Low-Cost, High Leverage Policy for Northeast States*, Summer 2002.

64. These savings include energy savings that would result from air conditioners meeting efficiency standards proposed during the Clinton administration. The Bush administration has attempted to weaken the proposed standards, but in January 2004, a federal appeals court overruled the decision, allowing the more stringent standards to take effect. Should the court's ruling be implemented, Rhode Island would gain the benefits of stronger air conditioner standards without state action.

65. See note 63.

66. Ibid.

67. See note 58.

68. Gigi Kellett, Maryland Public Interest Research Group, *The Maryland Energy Efficiency Standards Act SB 394*, personal communication, 19 March 2004.

69. 301 CMR 7.00 Appendix B.

70. American Council for an Energy-Efficient Economy, *Summary Table of Public Benefit Programs and Electric Utility Restructuring*, May 2003; Energy Information Administration, *Status of State Electric Industry Restructuring Activity: Rhode Island*, February 2003.

71. American Council for an Energy-Efficient Economy, *Summary Table of Public Benefit Programs and Electric Utility Restructuring*, May 2003.

72. National Grid, *2002 DSM Year-End Report for the Narragansett Electric Company*, 1 May 2003.

73. Ibid.

74. Energy Information Administration, *State Electricity Profiles: Rhode Island,* 2002.

75. Center for Clean Air Policy, *Connecticut Climate Change Stakeholder Dialogue: Recommendations to the Governor's Steering Committee*, January 2004.

76. The oil and natural gas savings estimated by the stakeholders are slightly lower than the emissions reductions we estimated because our projected savings are based on the benefits of various efficiency programs operated by Vermont Gas, whereas this calculation savings in the stakeholder plan is based on a discrete set of programs.

77. (Connecticut) Energy Conservation Management Board, *Energy Efficiency: Investing in Connecticut's Future*, 31 January 2003; (Massachusetts) Massachusetts Office of Consumer Affairs and Business Regulation, *2001 Energy Efficiency Activities: A Report by the Division of Energy Resources*, Summer 2003; (New Hampshire) Connecticut Valley Electric Company, Granite State Electric Company, New Hampshire Electric Cooperative, Public Service Company of New Hampshire, Unitil Energy Systems, *New Hampshire Core Efficiency Programs: Quarterly Report, June 1-December 31, 2002*, 13 February 2003 (savings estimate based on lifetime savings of efficiency measures in second half of 2002 divided by 15); (Rhode Island) Narragansett Electric Company, *Residential Energy Efficiency Programs* and Narragansett Electric Company, *Design 2000plus Energy Initiatives/Small Business Services*; PowerPoint presentations before the Rhode Island Greenhouse Gas Stakeholder Process, Buildings and Facilities Working Group, 29 November 2001, downloaded from http://righg.raabassociates.org/events.asp?type=grp&event=Buildings%20and%20Facilities; (Vermont) Efficiency Vermont, *2004 Annual Plan*, 31 October 2003 and Efficiency Vermont, *The Power of Ideas: Efficiency Vermont 2002 Annual Report*. Annual energy savings and spending figures based on the most recent year of data available.