A Blueprint for Action

Policy Options to Reduce New Jersey's Contribution to Global Warming

Environment New Jersey
Research and Policy Center

September 2006

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Executive Summary

New Jersey has begun to make significant strides toward reducing its emissions of global warming pollution, joining other states in the Northeast and across the country in pioneering efforts to reduce global warming pollution from cars and power plants, to boost the state's energy efficiency, and to increase our use of clean, renewable energy.

But the challenges posed by global warming are large, and the need for additional action to reduce emissions is immediate. Thankfully, many technologies and policy tools exist that could enable New Jersey to cut its emissions of global warming pollutants within the next two decades, while moving the state toward a clean, secure energy future.

This report details 11 policy strategies, in addition to four steps already taken, that would cut New Jersey's emissions of carbon dioxide—the leading greenhouse gas—by more than 7 percent below today's levels within the next two decades. Even with these strategies, however, New Jersey will still need to take additional steps to reduce its contribution to global warming in line with the reductions scientists believe will be necessary to prevent catastrophic climate change.

Global warming is real, is happening now, and poses a serious threat to New Jersey's future.

- Global average temperatures increased by 1°F in the 20th century and are now increasing at a rate of about 0.36°F per decade. Sea level is rising, ice and snow cover are decreasing, and hurricane intensity has increased.

- The consensus view of the scientific community is that much of the global warming that has occurred is due to human activities—particularly the burning of fossil fuels. Fossil fuel consumption releases carbon dioxide, which traps radiation emitted from the earth's surface. Since 1750, the concentration of carbon dioxide in the atmosphere has increased by 35 percent—leaving the concentration of carbon dioxide in the atmosphere higher than it has been in the last 650,000 years.

- Should the world continue on its present course, global warming emissions could triple in the next half century, with global temperatures increasing by 2.5 to 10°F over 1990 levels by 2100. Sea level could rise by between 3 inches and nearly 3 feet globally (and possibly much more), threatening low-lying coastal areas. And the ecological balance upon which life depends would be irrevocably altered.

- New Jersey, with its 127 miles of coastline and millions of coastal residents, is susceptible to negative impacts from global warming since much of the land area of the state is low-lying. Sea level rise of 2 to 4 feet would likely cause the inundation of as much as 1 to 3 percent of the state within the next century—including parts of Atlantic City, Cape May, the Delaware Bay Shore, Long Beach Island and the Meadowlands—while leaving large portions of the state susceptible to coastal flooding from major storms. (See Fig. ES-1.)

Fig. ES-1. Areas of New Jersey at Risk of Inundation or Coastal Flooding

Immediate action is needed to prevent the worst impacts of global warming.

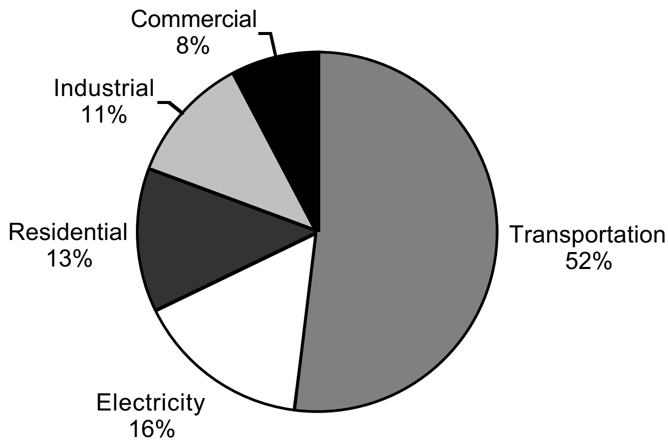
Scientists tell us that, if we act quickly and aggressively to reduce global warming emissions, there is a much greater chance of staving off the worst impacts of global warming. To have a reasonable chance of keeping global temperatures from rising by more than 2°C (3.6°F), the atmospheric concentration of carbon dioxide must be held below 450 parts per million (ppm). To achieve that target, the world will need to halt the growth of global warming pollution in this decade, begin reducing emissions soon, and slash emissions by more than half by 2050. Because the U.S. is the world's largest global warming polluter, the degree of emission reductions required here will be greater than in less-developed countries.

By adopting an aggressive target for reducing global warming pollution and setting in motion the changes that will meet that target, New Jersey can set an example for the rest of the nation, while reducing its own significant contribution to global warming.

Emissions of global warming pollution are on the rise in New Jersey.

- Between 1990 and 2002, New Jersey's emissions of carbon dioxide from energy use increased by 8 percent. Transportation produces the largest share of carbon dioxide pollution in the state (52 percent), followed by electricity generation (16 percent), and the direct use of fossil fuels in homes (13 percent), industry (11 percent) and businesses (8 percent). (See Fig. ES-2.) New Jersey also produces emissions through the consumption of electricity generated in other states.
- New Jersey is on a path that will lead to significant increases in global warming emissions over the next several decades. According to a projection based on data from the U.S.

Fig. ES-2. New Jersey Carbon Dioxide Pollution by Sector, 2002



Energy Information Administration (EIA), New Jersey's emissions of carbon dioxide from energy use could increase by 26 percent over 2000 levels by 2025, with increases in emissions from the transportation sector and electricity generation responsible for the bulk of emissions growth.

New Jersey has already committed to actions that will curb the growth of carbon dioxide emissions over the next two decades.

Over the past several years, New Jersey has taken important steps to limit global warming emissions from vehicles and power plants, to improve the energy efficiency of the state's economy, and to increase the use of renewable energy for electric power generation. These actions—if fully implemented—would hold the growth of carbon dioxide emissions to just 10 percent between 2002 and 2025, compared to the 26 percent growth that would be expected with no policy action. (See Fig. ES-3, next page.)

New Jersey could reduce its contribution to global warming by adopting 11 key policy strategies.

There are numerous tools available to New Jersey to reduce global warming pollution. Among the options are the following policies to reduce carbon dioxide emissions from energy use:

1. Require the sale of **energy-saving replacement tires** that improve vehicle efficiency without negatively affecting safety.

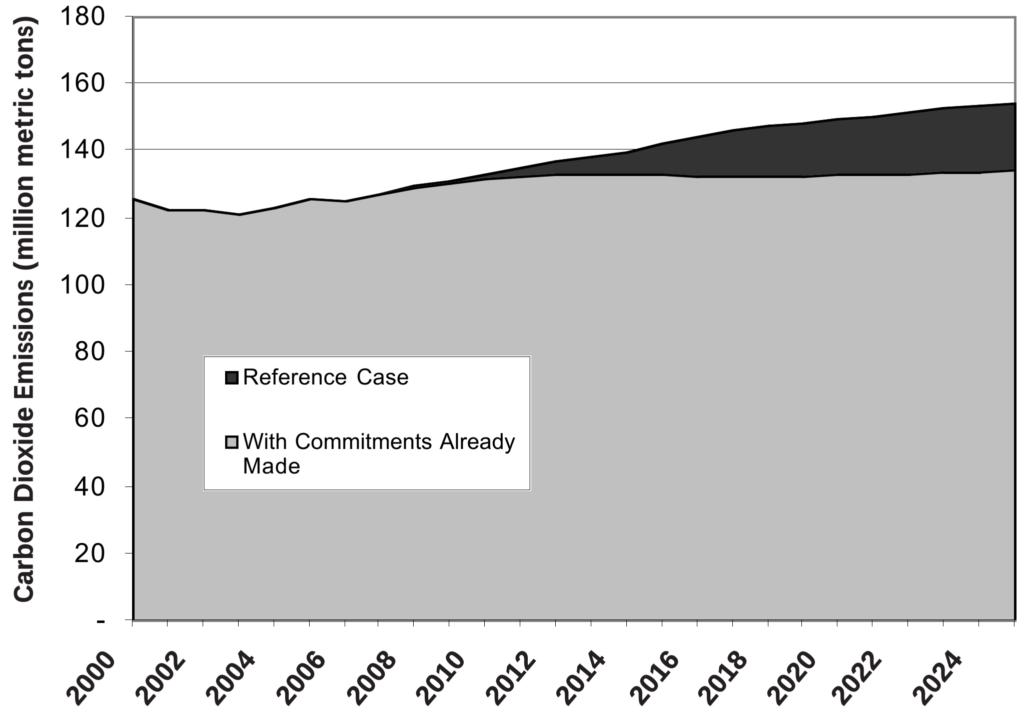
2. Require automobile insurers to offer **pay-as-you-drive automobile insurance**, in which insurance rates are calculated by the mile, rewarding those who drive less while potentially reducing accidents.

3. **Reduce the number of automobile commutes** by requiring large employers to develop programs to discourage single-passenger commuting and provide employees with more transportation choices.

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

5. Improve New Jersey's **freight rail infrastructure**, allowing more goods to move by rail and fewer by truck.

Fig. ES-3. Carbon Dioxide Emissions in New Jersey with Commitments Already Made



6. Push federal officials to increase **fuel economy standards** for cars and light trucks to at least 40 miles per gallon within the next decade.
7. Significantly strengthen New Jersey's residential and commercial **building energy codes**.
8. Adopt significantly stronger **energy efficiency standards** for appliances and equipment.
9. Establish an **aggressive energy efficiency goal** and increase funding for New Jersey's existing energy efficiency programs.
10. Expand use of **combined heat and power**, in which commercial and industrial facilities use the same energy to generate both electricity and useful heat.
11. Adopt measures to **reduce government energy use** and promote the use of clean energy in government buildings.

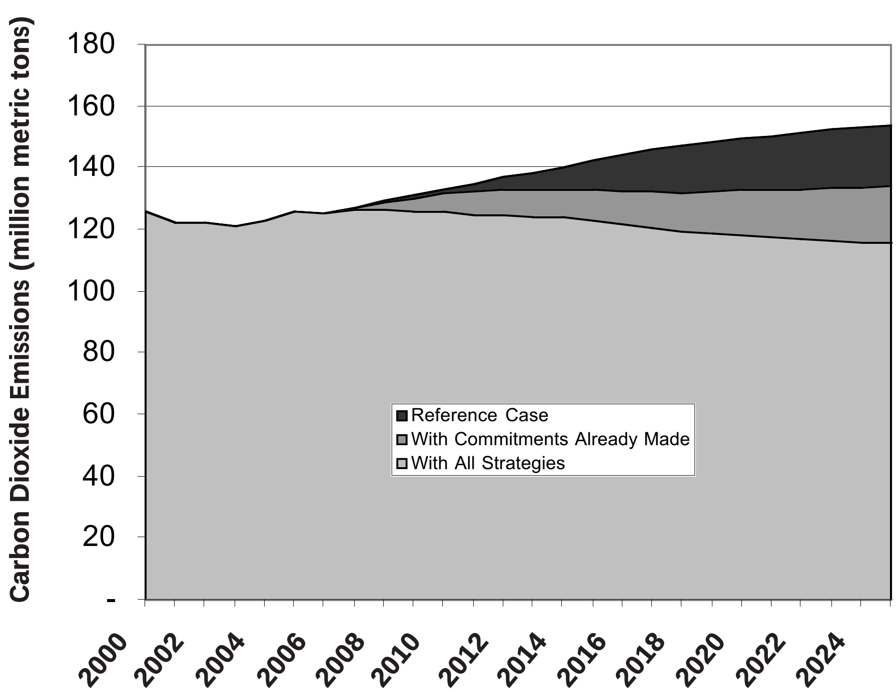
Adoption of these strategies would reduce global warming pollution while improving New Jersey's energy efficiency. (See Fig. ES-4.) By 2020, New Jersey's emissions of carbon dioxide would be approximately 6 percent below 2005 levels. By 2025, carbon dioxide emissions would be about 7.4 percent below 2005 levels.

New Jersey should commit to reducing its emissions of global warming pollutants to levels consistent with the targets scientists believe we need to meet to avoid catastrophic climate change, and adopt public policies sufficient to achieve those reductions. Specifically, the state should:

- Commit to achieving reductions in global warming emissions of 20 percent by 2020 and of at least 70 percent by 2050. Adoption of a strong cap on global warming emissions at the state, regional or federal level would ensure that New Jersey achieves that goal.

- Ensure the full implementation of emission-reduction policies already adopted.
- Adopt the 11 additional strategies recommended in this report.
- Take additional actions to reduce global warming pollution, including:
  - o Pursuing an economy-wide cap on global warming pollution at the state, regional or federal level, thus providing a financial incentive for the phase-out of heavily polluting energy sources and encouraging the development of cleaner sources of energy.
  - o Requiring owners of passenger vehicles with the lowest fuel efficiency to pay a fee to provide incentives for the purchase of more fuel-efficient vehicles.
  - o Working with other northeastern states to strengthen the Regional Greenhouse Gas Initiative in order to achieve greater reductions in carbon dioxide emissions from the state's power plants.
  - o Investigating options for additional policies to reduce global warming pollution, especially in areas not directly addressed in this report, such as emissions from air travel and industrial energy use and emissions of global warming pollutants other than carbon dioxide.

Figure ES-4. New Jersey's Carbon Dioxide Emissions from Energy Use after Adoption of Recommended Strategies



Introduction

New Jersey has a knack for reinvention. In the 19th century, the Garden State transformed itself from an agricultural state into an industrial powerhouse, drawing immigrants from around the world to run the mills of Paterson, Newark, Camden and Trenton. From the Menlo Park workshop of Thomas Edison sprang inventions that made New Jersey the "high tech" center of its time. In the 20th century, New Jersey set the pattern for post-war suburbanization, with modern highways like the New Jersey Turnpike and Garden State Parkway laying the groundwork for the state's historic love affair with the automobile. Later, New Jersey was among the first states to come to grips with the environmental damage caused by its industrial past, consistently enacting landmark laws to protect its fragile environment.

Now, at the outset of the 21st century, New Jersey faces the prospect of reinvention yet again.

One way in which the state could be reinvented over the next century—and not for the better—is through global warming. Climate scientists tell us that the earth is heating up, that human activities (especially the burning of fossil fuels) are the primary cause, and that further warming is inevitable unless the world begins to reduce its emissions of pollutants that trap heat in the earth's atmosphere.

For New Jersey, the threat posed by global warming is serious. As a mainly low-lying coastal state, New Jersey is susceptible to the dangers of global warming-induced sea level rise, not to mention the many other ecological and economic threats posed by dramatic climate change. Over the next century, if current trends continue, New Jersey could lose much of what makes our state special—from portions of the Jersey Shore to large chunks of the Meadowlands—and could be forced to respond to unprecedented economic, environmental and public health challenges.

There is, however, another path possible for New Jersey, one that weaves together many of the themes of the state's past reinventions—technological progress, strategic investments in infrastructure, and environmental leadership among them—to create a new future for the Garden State that helps protect us from the dangers of global warming while reducing our dependence on fossil fuels.

Over the past several years, New Jersey

has taken significant steps toward a clean energy future that reduces our impact on the global climate. New Jersey has committed to reducing global warming pollution from the cars and light trucks on our roads, to dramatically boosting our use of renewable energy, and to improving the energy efficiency of our economy. Working with our neighbors in the Northeast, we have also been among the leaders in negotiating a first-of-its-kind regional cap on carbon dioxide pollution from power plants. And throughout New Jersey, individuals, businesses and government are working in ways both large and small to save energy and reduce our state's global warming pollution.

There is much more New Jersey can—and must—do to reduce its contribution to global warming and reinvent itself as a clean energy state. This report examines 11 strategies that, if combined with commitments already made, would reduce New Jersey's global warming emissions by about 7 percent within the next two decades, and would move the state toward the dramatic emission reductions that scientists tell us will be necessary to prevent the worst impacts of global warming.

New Jersey can't stop global warming on its own. But we have a responsibility to do our share. And our state's history—from the Industrial Revolution to the electric light to suburbia to environmentalism—tells us that what happens in Jersey doesn't stay in Jersey. Time and again, New Jersey has shown the rest of the nation and the rest of the world how to do things differently.

Now is the time for us to do it again.

Global Warming and New Jersey

Global Warming is Happening

Global warming threatens to endanger New Jersey's future health, well-being and prosperity. The first signs of global warming are beginning to appear in New Jersey and throughout the world. Global temperatures and sea level are on the rise. Other changes, such as the recent increase in the severity of hurricanes, are consistent with the kinds of changes scientists expect to occur on a warming planet and are harbingers of the dramatic climate shifts that await us if global warming pollution continues unabated.

Rising Global Temperatures

Global average temperatures increased during the 20th century by about 1˚F (0.56˚C). While this increase may not seem extreme, it is unprecedented in the context of the last 1,000 years of world history.[1] In addition, variability exists in the warming trend that can cause a specific region to warm either much more or less than the global average. Figure 1 shows temperature trends in the Northern Hemisphere 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.

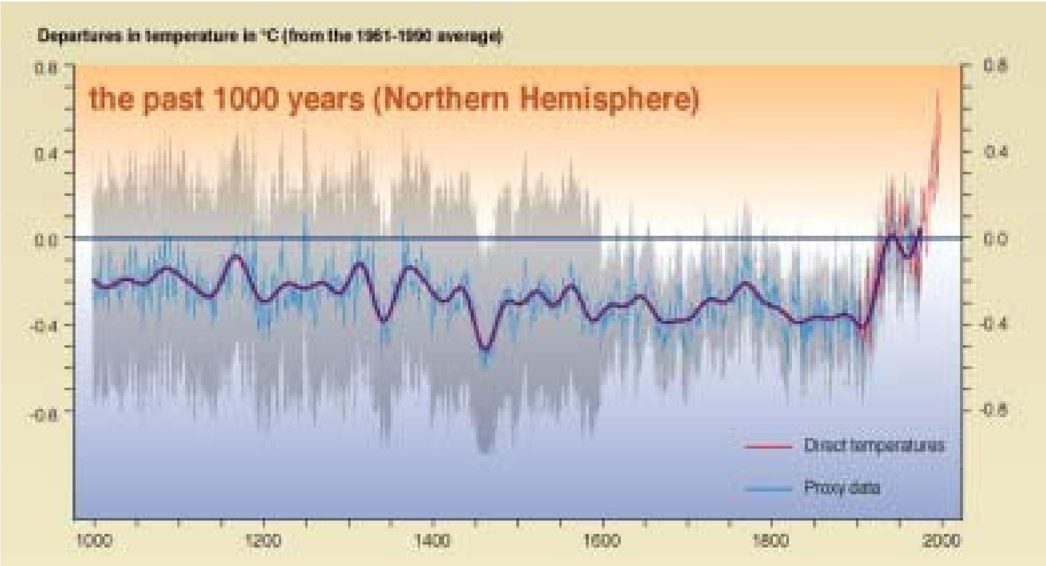
Global warming appears to have intensified in recent years. In 2006, the National Aeronautics and Space Administration (NASA) reported that, since 1975, temperatures have been increasing at a rate of about 0.36˚F (0.2˚C) per decade.[3] The first six months of 2006 were the hottest such period in the U.S. over more than a century of record-keeping, with temperatures averaging 3.4˚F (1.9˚C) higher than the average for the 20th century, while 2005 was the hottest year on record worldwide.[4] Nineteen of the 20 hottest years ever recorded have occurred since 1983 and nine of the 10 hottest years have occurred since 1995.[5]

This warming trend cannot be explained by natural variables—such as solar cycles or volcanic eruptions—but is successfully predicted by models of climate change that include human influence.[6]

Melting Ice

The rise in global temperatures has resulted in thinning ice and decreasing snow cover. Over the last three decades, the volume and

Fig. 1. Northern Hemisphere Temperature Trends[2]



extent of ice cover in the Arctic has been declining rapidly, leading to the possibility that the Arctic could be ice-free during the summer by the end of this century.[7] Mountain glaciers around the world have been retreating, and since the late 1960s, Northern Hemisphere snow cover has decreased by 10 percent.[8]

Rising Sea Levels

Oceans have risen with the melting of glacial ice and the expansion of the ocean as it warms. Average sea level has risen 0.1 to 0.2 meters (4 to 8 inches) in the past century.[9] Sea level rise has already helped cause the inundation of some coastal land. In Chesapeake Bay, 13 islands have disappeared entirely since the beginning of European settlement four centuries ago.[10] Louisiana loses approximately 24 square miles of wetlands each year, causing an increase in the destructive potential of hurricanes like Hurricane Katrina.[11] While development and land subsidence contribute to the loss of coastal land in these areas, rising sea levels also have an impact, and threaten even greater changes in coastal areas in the decades to come.

More Severe Storms

Storms throughout the middle and high latitudes of the Northern Hemisphere may be getting more intense. For example, an increase in the fraction of rainfall occurring as heavy precipitation events has been observed. This may be arising from a number of causes, including changes in atmospheric moisture, thunderstorm activity and large-scale storm activity.[12]

In addition, hurricanes appear to have become more powerful and more destructive over the last three decades, a phenomenon that some researchers link to increasing global temperatures.[13] Existing hurricane observations indicate that the number of Category 4 and Category 5 hurricanes has increased substantially worldwide over the last 35 years.[14] And the Atlantic hurricane season of 2005 was the worst ever recorded with the most named storms (28), the most hurricanes (15), the most Category 5 hurricanes (4), the most major hurricanes to hit the U.S. (4), the costliest hurricane (Katrina, which caused more than $80 billion in damage), and three of the six strongest hurricanes recorded (Wilma, the strongest ever, plus Katrina and Rita).[15]

Climate Change in New Jersey

New Jersey's climate has changed significantly over the past century.

New Jersey has been getting hotter. The mean temperature in New Jersey over the 1971-to-2005 period was 1.0°F (0.56°C) hotter than the mean temperature from 1895 to 1970, according to an analysis by the Office of the New Jersey State Climatologist.[16] (See Fig. 2.) Of the 11 hottest years in New Jersey since record-keeping began, three have occurred since 2001 and seven have occurred since 1990.[17]

New Jersey has been getting wetter. An analysis by the Office of the New Jersey State Climatologist suggests that precipitation in the state has also increased. The mean annual precipitation over the 1971-to-2005 period was more than three inches higher than the average from 1895 to 1970.[19] (See Fig. 3.)

New Jersey's recent weather has been variable. Over the past several years, New Jersey has experienced great weather variability and a string of extreme weather events. For example, August and September 2005 were the driest combined August-September on record. They were followed immediately by the wettest single month ever recorded in New Jersey (October 2005). March 2006 was the driest March on record, and June 2006 was the fifth-wettest June.[20]

Extreme weather events during the last several years have proven to be very costly. The Delaware River has experienced three major floods—the worst since the mid-1950s—since September 2004. The first two of those floods, in September 2004 and April 2005, caused a combined $58 million in estimated damages.[21]

While these extreme events cannot be linked with certainty to global warming, greater weather variability and more extreme

Fig. 2. Annual Mean Temperatures in New Jersey[18]

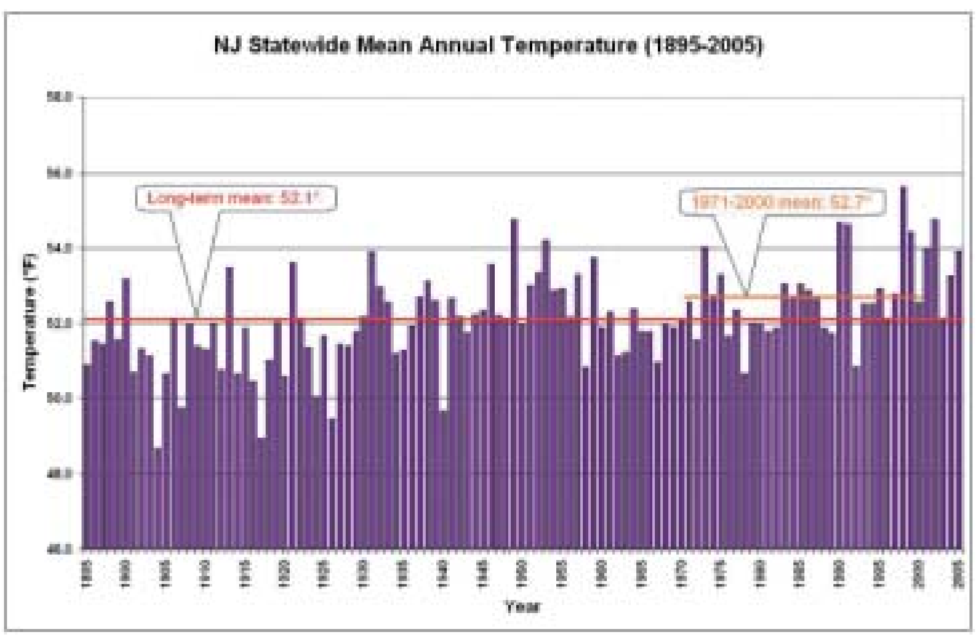
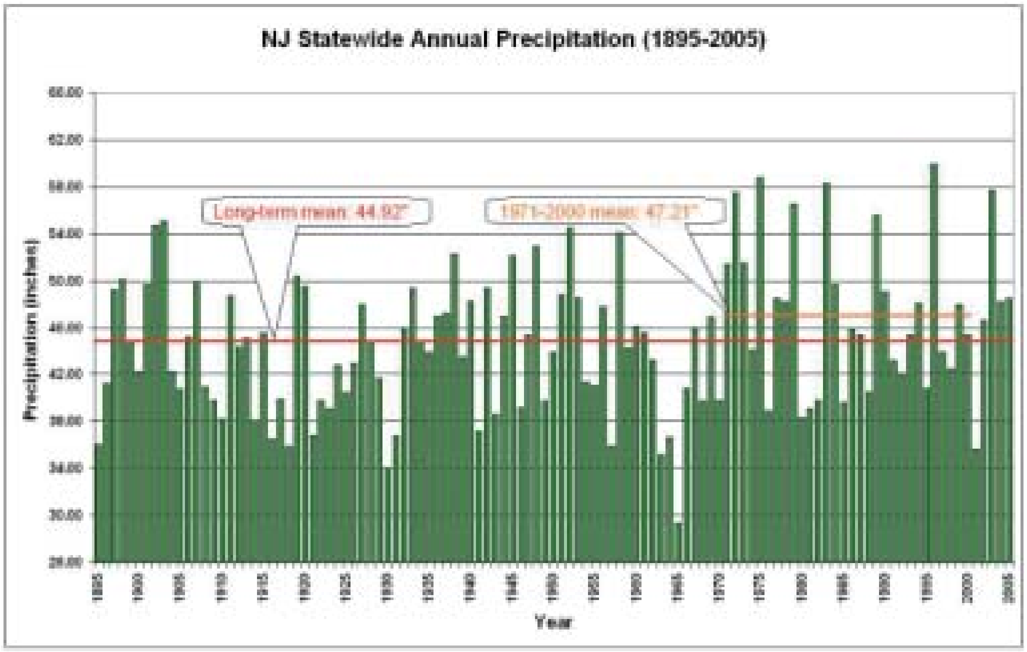


Fig. 3. New Jersey Annual Precipitation



weather events are among the changes scientists believe could result from global warming.[22]

Sea level is rising. Global warming has contributed to the rise in sea level along New Jersey's coastline. The sea level along New Jersey's coastline has been increasing at a rate of about 3.8 millimeters (0.15 inches) per year, with approximately half of that rise due to human-induced climate change (and the other half due to land subsidence).[23]

Human Activities are Causing Global Warming

Many of the changes described above are consistent with the kinds of climatic shifts scientists believe will occur as a result of human-caused global warming. They are also signs that human activities resulting in the release of pollutants (known as greenhouse gases or global warming pollutants) are causing climate change.

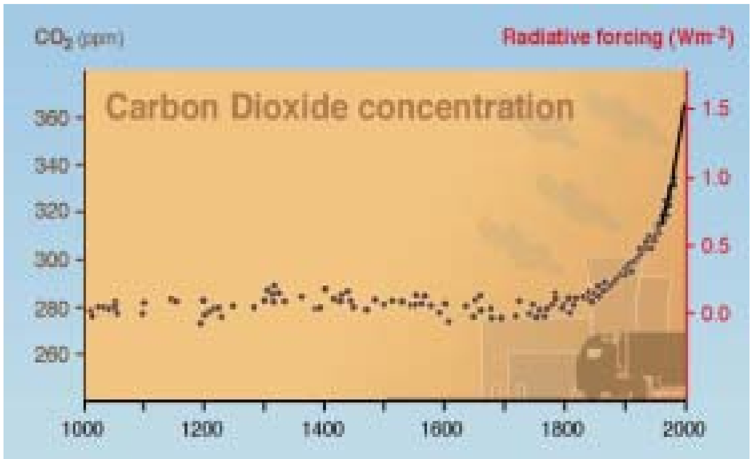
The Greenhouse Effect

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, absorb infrared radiation emitted from the earth's surface and subsequently heat the atmosphere and warm the surface. The greenhouse effect is necessary for the survival of life; without it, temperatures on earth would be too cold for humans and other life forms to survive.

But human activities, particularly over the last century, have altered the composition of the atmosphere in ways that intensify the greenhouse effect.

Since 1750, for example, the concentration of carbon dioxide (the leading global warming pollutant) in the atmosphere has increased by 35 percent as a result of human

Fig. 4. Atmospheric Concentration of Carbon Dioxide[26]



activity.[24] The rate at which carbon dioxide concentrations have increased has accelerated over the past century as we have come to burn more fossil fuels. The current concentration of carbon dioxide in the atmosphere is higher than it has been in the last 650,000 years.[25] Concentrations of other global warming pollutants have increased as well. (See Fig. 4.)

Global Warming Will Have Severe Impacts Unless We Act Now

Climate scientists warn that the world faces dire environmental consequences unless we find a way to reduce quickly our emissions of global warming pollutants. Due to its coastal location and low elevation, New Jersey could be hit especially hard by global warming.

Global Impacts

Many scientists and policy-makers (such as the European Union) recognize a 2° Celsius (3.6° Fahrenheit) increase in global average temperatures over pre-industrial levels as a rough limit beyond which large-scale, dangerous impacts of global warming would become unavoidable.[30] Even below 2°C, significant impacts from global warming are likely, such as damage to many ecosystems, decreases in crop yields, sea level rise, and the widespread loss of coral reefs.[31]

Beyond 2°C, however, the impacts of global warming become much more severe, including some or all of the following possible impacts:

- Eventual loss of the Greenland ice sheet, triggering a sea-level rise of 7 meters (23 feet) over the next millennium (and possibly much faster)[32];
- A further increase in the intensity of hurricanes;
- Loss of up to 97 percent of the world's coral reefs;
- Displacement of tens of millions of people due to sea level rise;
- Total loss of Arctic summer sea ice;
- Expansion of insect-borne disease;
- Greater risk of positive feedback effects —such as the release of methane stored in permafrost—that could lead to even greater warming in the future.[33]

At temperature increases of 3 to 4°C (5.4 to 7.2°F), far more dramatic shifts could take place, including:

- Increased potential for shutdown of the thermohaline circulation, which carries warmth from the tropics to Europe;
- Increased potential for melting of the West Antarctic ice sheet, triggering an eventual 5 to 6 meter (16 to 20 foot) rise in sea level;
- Major crop failures in many parts of the world;
- Extreme disruptions to ecosystems.[34]

In addition, the more global temperatures rise, the greater the risks of abrupt climate change increase.

Global Warming Pollutants

Human activities result in the release of many pollutants that are capable of altering the global climate. The main pollutants that contribute to global warming are the following:

- **Carbon dioxide** – Carbon dioxide is released mainly through the combustion of fossil fuels. Carbon dioxide emissions are the leading contributor to global warming and the leading global warming pollutant released in the United States. In 2004, carbon dioxide emissions represented approximately 84 percent of the U.S.'s annual contribution to global warming.[27]

- **Methane** – Methane gas escapes from garbage landfills, is released during the extraction of fossil fuels, and is emitted by livestock and some agricultural practices. Methane represents about 9 percent of U.S. global warming emissions.

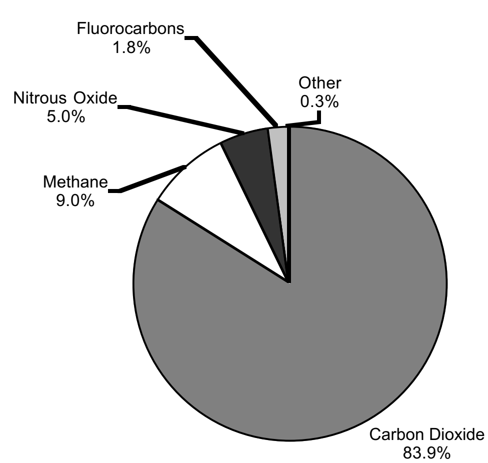
- **Nitrous Oxide** – Nitrous oxide is released in automobile exhaust, through the use of nitrogen fertilizers, and from human and animal waste, and is responsible for about 5 percent of the U.S. contribution to global warming.

- **Fluorocarbons** – Used in refrigeration, air conditioning and other products, many fluorocarbons are also global warming pollutants. Emissions of some fluorocarbons have increased significantly in recent years as they have been used to replace ozone-depleting substances. However, because they are generally emitted in small quantities, fluorocarbons are responsible for only about 2 percent of the U.S. contribution 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. It is released only in very small quantities and is responsible for only a very small portion of the nation's global warming emissions, but there are cost-effective alternatives for controlling existing emissions.

- **Black Carbon** – Black carbon is a product of the burning of fossil fuels, particularly coal and diesel fuel. Recent research has suggested that, because black carbon absorbs sunlight, 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, and it is difficult to judge exactly how large a role black carbon might play in the U.S.'s contribution to global warming.[28]

Fig. 5. U.S. Global Warming Emissions by Pollutant (carbon dioxide equivalent)[29]



Should the world continue on its current course, with fossil fuel consumption continuing to rise, temperature increases of well above 2°C are likely to occur. The Intergovernmental Panel on Climate Change, in its 2001 Third Assessment Report, laid out a scenario in which population, economic output and fossil fuel consumption continue to grow dramatically. Under that scenario, the concentration of carbon dioxide in the atmosphere in 2100 would be nearly three-and-a-half times its preindustrial level, global average temperatures by the end of the century would be approximately 4.5°C (8.1°F) higher than in 1990, and temperatures would continue to rise for generations to come.[35]

New Jersey Impacts

New Jersey is vulnerable to the impacts of global warming, in part due to its coastal location and low elevation and in part due to its large urbanized (and suburbanized) areas.

New Jersey's future is particularly threatened by rising sea level. Three-fifths of New Jersey residents live in the state's coastal counties, with many of them living on or near the coastline itself.[36] Coastal attractions like the Jersey Shore and Atlantic City make a sizable contribution to New Jersey's tourism industry, which generates $32 billion in economic activity annually.[37] The state's 127-mile coastline also supports economically important shipping and fishing industries. The coastline is a valuable ecological resource, with coastal marshes that reduce damage from severe storms and provide habitat for 11 endangered species.[38]

Scientists expect that sea level along the New Jersey shore will increase between 0.31 and 1.1 meters (1 to 3.6 feet) over the next century, though higher levels of sea-level rise are possible if global warming emissions worldwide continue to increase.[39] Because New Jersey's coastal areas are relatively low-lying, they are especially susceptible to being flooded by rising seas. A sea level rise of 2 feet, for example, would put approximately 1 percent of the state's land area underwater, with a sea level rise of 4 feet inundating approximately 3 percent of the state. Such a rise in sea level would also leave 9 percent of the state's land area vulnerable to periodic coastal flooding.[40] Among the areas vulnerable to submersion are parts of Atlantic City, Cape May, the Delaware Bay shore and the Meadowlands.[41] (See Fig. 6.) Rising seas would also leave areas such as Long Beach Island at increased risk of coastal flooding during severe storms.

In addition to the direct impacts of submersion and coastal flooding, rising sea level also threatens the stability of the state's beaches, which are cornerstones of New Jersey's tourism economy, and can lead to saltwater intrusion of coastal aquifers, which are a major source of drinking water and water for agriculture.[42]

Coastal areas of New Jersey aren't the only ones at risk from global warming. Higher temperatures could lead to more days of extreme heat throughout the state during the summertime, exacerbating heat stress among the elderly and the formation of ozone smog.[43] Warmer, wetter conditions could lead to increasing spread of vector-borne diseases such as malaria and West Nile Virus.[44] The state's transportation infrastructure—particularly its bridge and tunnel links with New York City—would face growing threats from storm surges.[45] Global warming can also be expected to have impacts on New Jersey's agricultural economy and on its forest and other ecosystems.

The Need for Immediate Action

There is hope in the climate science, however. Scientists tell us that, if we act quickly and aggressively to reduce global warming emissions, there is a much greater chance of staving off the worst impacts of global warming. To have a reasonable chance of keeping global temperatures from rising by more than 2°C, the atmospheric concentration of carbon dioxide must be held below 450 parts per million (ppm)—about 60 percent higher than pre-industrial levels and about 18 percent higher than today.[46] Holding concentrations below 400 ppm would be even more effective.

To stabilize carbon dioxide levels at 450 ppm, however, the world will need to halt the growth of global warming pollution in this decade, begin reducing emissions soon, and slash emissions by more than half by 2050.[47] Greater reductions would be required to limit carbon dioxide levels to 400 ppm. Because the U.S. is the world's largest global warming polluter, the degree of emission reductions required here will be greater than in less-developed countries—as much as 70 to 85 percent below today's levels.

By adopting an aggressive target for reducing global warming pollution and setting in motion the changes that will meet that target, New Jersey can set an example for the rest of the nation, while reducing its own significant contribution to global warming.

Fig. 6. Areas of New Jersey at Risk of Inundation or Coastal Flooding

Global Warming Pollution in New Jersey

New Jersey is a significant contributor to global warming, mainly through the release of carbon dioxide resulting from consumption of fossil fuels. In 2002, the last year for which complete data are available, the use of energy in New Jersey was responsible for the release of approximately 122 million metric tons of carbon dioxide, the leading global warming pollutant.[48] Were New Jersey its own country, it would have ranked 32nd in the world for emissions during 2002, ahead of nations such as Argentina, Greece and Israel.[49]

New Jersey's emissions of carbon dioxide have been increasing and are likely to increase still further in the years to come in the absence of concerted action to reduce global warming pollution. Various sectors of New Jersey's economy are responsible for varying amounts of global warming pollution and will require different strategies to reduce emissions.

Global Warming Pollution on the Rise

Between 1990 and 2002, carbon dioxide emissions from energy use in New Jersey increased by 8.9 $MMTCO_2$—or about 8 percent—a rate of increase significantly lower than the U.S. as a whole, which has seen carbon dioxide emissions increase by 15 percent during that same period.[50]

New Jersey's emissions of carbon dioxide are expected to rise over the next two decades. In the absence of measures to reduce global warming pollution (including several measures New Jersey has already committed to implement), the state's carbon dioxide emissions could be expected to increase by nearly 22 percent over 2002 levels by 2020 and by 25 percent over 2002 levels by 2025. (See Fig. 7.)

Over the next two decades, New Jersey's emissions from all sectors can be expected to increase, with the greatest increases taking place in transportation and electricity generation. In absolute terms, the greatest increases are likely to take place in the transportation sector, with an increase of 17 $MMTCO_2$ possible between 2002 and 2025. Carbon dioxide pollution from electricity generation can be expected to increase by 11 $MMTCO_2$, with smaller increases in emissions resulting from direct use of fossil fuels in the residential (1.5 $MMTCO_2$), commercial (1.4 $MMTCO_2$) and industrial (0.2 $MMTCO_2$) sectors. (See Fig. 8.)

Fig. 7. Projected New Jersey Carbon Dioxide Emissions, Reference Case

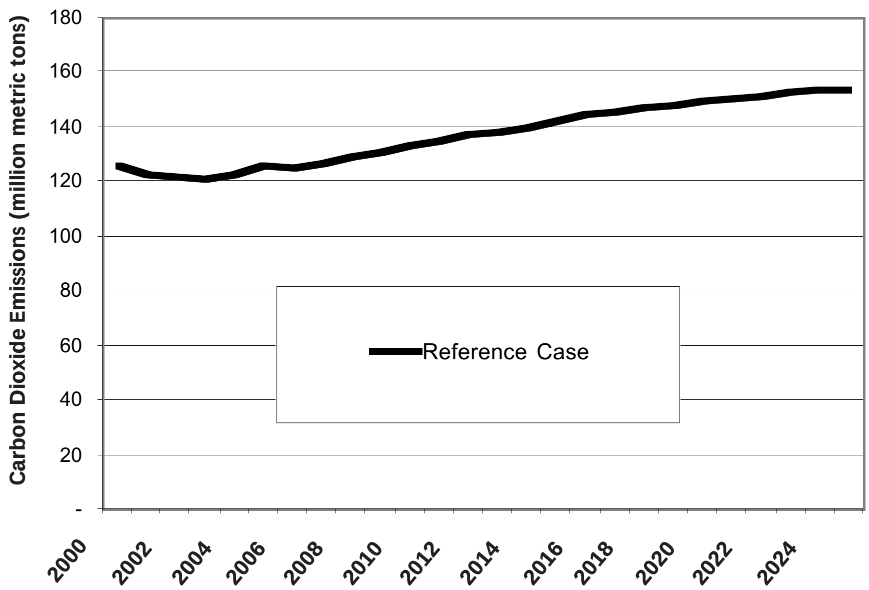
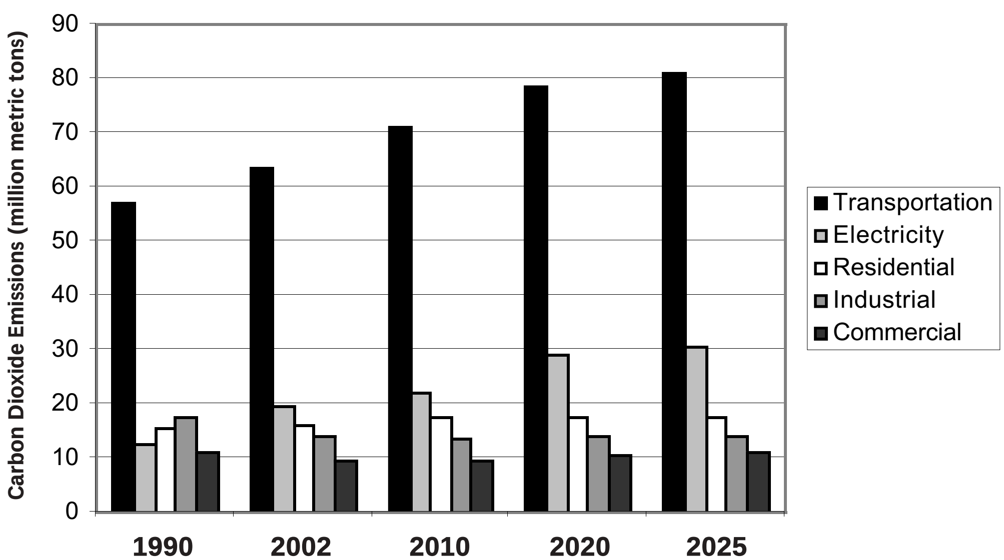


Fig. 8. Historic and Projected New Jersey Carbon Dioxide Emissions by Sector



Counting Global Warming Pollution: Background on this Analysis

There are many ways to calculate a state's impact on the global climate. Esti-mates of global warming pollution and pollution trends depend on the origi-nal data source used and the types of emissions that are included or left out.

In this document, we use energy consumption data and projected regional trends compiled by the U.S. Energy Information Administration (EIA) as the basis of our estimates of New Jersey's past, current and future carbon dioxide emissions (called the "reference case" in this report). The methods we used to project future emissions are described in detail in the "Methodology" section at the end of this report.

This report includes only energy-related emissions of carbon dioxide and not emissions of other global warming pollutants (like methane and nitrous oxide). In addition, our estimates are calculated on a *production* basis—that is, based on emissions that take place within New Jersey's borders. An alternative approach would be to calculate emissions on a *consumption* basis, including all emissions resulting from the consumption of energy or products within New Jersey, regardless of where the actual emissions take place. This distinction is especially important with regard to the electricity sector, since New Jersey is a net importer of electricity from other states. Our estimates only include emissions from electricity that is generated within New Jersey's borders, and not emissions from power plants in other states that generate electricity for use in New Jersey.

Because we calculate emissions on a production basis, we also generally do not include "upstream" emission reductions (for example, from reduced production of gasoline in other states due to reduced demand from vehicles in New Jersey) in our estimates of pollution savings from the various strategies discussed in this report. As a result, many of the strategies discussed will deliver greater overall emission reductions than are estimated here.

Finally, there are multiple ways of expressing quantities of global warming emissions. We have chosen to express emissions in terms of million metric tons of carbon dioxide (or $MMTCO_2$). Some other studies use million metric tons of carbon or carbon equivalent (MMTCE) as the unit of measure. To convert carbon equivalent to carbon dioxide, one can simply multiply by 3.67.

These factors can make it difficult to compare emission estimates made using different methodologies and assumptions. The New Jersey Department of Environmental Protection (DEP) issues global warming emission inventories that include a wider set of emissions calculated according to a different set of assumptions. A summary of the DEP inventory can be found at www.nj.gov/dep/dsr/trends2005/pdfs/ghg.pdf.

Sources of Carbon Dioxide Emissions in New Jersey

A coherent strategy to address global warming pollution in New Jersey must begin from an understanding of the sources of the pollution. Transportation is the leading source of global warming emissions in New Jersey, but emissions from all sectors of the economy are projected to increase to varying degrees over the next two decades.

Transportation

New Jersey's contribution to global warming is dominated by its transportation sector. In 2002, transportation accounted for more than half (52 percent) of the state's energy-related carbon dioxide emissions. Between 1990 and 2002, global warming pollution from transportation increased by 11 percent—only emissions from electricity generation grew at a faster rate.

Personal vehicles such as cars, pick-up trucks and SUVs are the main sources of global warming pollution in New Jersey, accounting for a little more than half of the state's transportation-related emissions.[51] The number of miles traveled on New Jersey's highways has increased by 41 percent since 1980, to nearly 73 billion miles per year.[52] Population growth accounts for some of the increase, but the number of vehicle-miles traveled per capita has also increased by 19 percent between 1980 and 2004.[53]

New Jersey's status as a transportation hub also contributes to its impact on global warming. Nearly one-fifth of New Jersey's transportation-related carbon dioxide emissions result from combustion of jet fuel. Newark Liberty Airport is the nation's 14th busiest airport and the world's 23rd busiest, serving more than 33 million passengers in 2005.[54] In addition to its high passenger load, Newark Airport is an important departure point for long-distance travel, serving as a hub for Continental Airlines and ranking fifth in the nation for passenger miles from international departures.[55]

New Jersey's highways are also major corridors for the shipment of freight along the East Coast. Trucks accounted for 8.8 percent of the miles traveled on New Jersey highways during 2002 and their numbers are expected to increase over time.[56]

Finally, New Jersey's ports are important international freight hubs. Consumption of residual petroleum fuel in the transportation sector (the vast majority of which is used to fuel ships) accounted for just over 10 percent of New Jersey's transportation-related global warming emissions in 2002.

Over the next two decades, global warming pollution from gasoline consumption in New Jersey (most of it used in cars and light trucks) is expected to increase by approximately 31 percent, while consumption of diesel fuel (used primarily in heavy-duty trucks, as well as trains) is poised to increase by more than 59 percent. Reducing global warming emissions from New Jersey's transportation sector, therefore, will require action on a number of fronts, with efforts to reduce emissions from personal vehicle travel the most pressing, but action on freight emissions required as well.

Electricity Generation

Power plants are the second largest source of carbon dioxide in New Jersey, responsible for about 16 percent of the state's emissions. Adding in emissions from out-of-state power plants that supply electricity to New Jersey would increase the climate impact of electricity consumption in New Jersey by more than 50 percent.[57]

Emissions from electricity generators increased by more than 50 percent between 1990 and 2002, representing the largest percentage increase in any sector of the state's economy. But the increase in emissions is somewhat deceiving. In 1990, New Jersey imported more than one-third of the power it consumed from other states. By 2002, as a result of a dramatic increase in the generation of power from natural gas and a smaller increase in nuclear power generation, New Jersey was generating more than 80 percent of the power it consumed.[58] Because of this shift, a greater share of the emissions that result from electricity consumption in New Jersey now take place within the state and are counted in the emission estimates used in this report.

The vast majority of global warming emissions from electric generation in New Jersey come from coal and natural gas-fired power plants. (New Jersey's nuclear power plants, which generate nearly half the state's electricity, produce no direct carbon dioxide emissions, but do have significant environmental and public safety impacts. See "The Future of Nuclear Power in New Jersey," page 30.) New Jersey's coal-fired power plants produce more than half of all carbon dioxide emissions from power generation in New Jersey, despite the fact that those plants produce only 18.5 percent of the power generated in the state.[59] In recent years, New Jersey has increasingly turned to natural gas as a source of electricity. Emissions from natural gas-fired power plants in the state increased by 140 percent between 1990 and 2002, while the amount of power generated from those plants increased by 130 percent.[60]

One of the major challenges facing New Jersey is how to replace the power generated by the three nuclear reactors (Oyster Creek and Salem units I and II) scheduled to go off-line between now and 2025. By using energy efficiency improvements and renewable energy to replace that power, New Jersey can avoid the dramatic increase in global warming emissions that would result if that generation is replaced by increases in coal or natural gas-fired power plants—as well as the public safety and environmental dangers that would result if those plants are kept open or replaced with new nuclear reactors.

Residential, Commercial and Industrial Energy Use

Direct consumption of fossil fuels in New Jersey homes (not including electricity consumption) accounted for about 13 percent of the state's carbon dioxide emissions in 2002. Consumption of natural gas and petroleum for home heating and other household uses has increased only modestly since 1990, despite a 10 percent increase in New Jersey's population during that time.[61] Household consumption of electricity, however, has increased dramatically—28 percent between 1990 and 2002—helping to fuel the rapid rise in carbon dioxide emissions from electricity generation.[62]

Industrial energy consumption (again, not counting electricity use) accounted for 11 percent of New Jersey's carbon dioxide emissions in 2002. Carbon dioxide emissions from industrial energy use declined by 21 percent between 1990 and 2002 as the state lost significant amounts of industrial capacity and as New Jersey industries improved their energy efficiency. Electricity consumption declined dramatically as well, with New Jersey industry consuming 24 percent less electricity in 2002 than it did in 1990.[63] The chemical industry, New Jersey's largest industry in terms of economic output, has seen dramatic improvements in energy efficiency nationwide, with energy consumption per unit of output declining by 40 percent over the last 25 years.[64] Carbon dioxide emissions from industry are expected to increase only modestly over the next two decades.

Direct fossil fuel consumption in commercial buildings accounts for the remaining 8 percent of New Jersey's carbon dioxide emissions. Carbon dioxide pollution from commercial buildings declined by 13 percent between 1990 and 2002, as businesses switched from higher-polluting petroleum to natural gas for space heating and other energy needs. However, as with residential buildings, electricity consumption increased dramatically (32 percent) in commercial buildings over that time period, helping to fuel the increase in global warming emissions from electricity generators since 1990.[65]

Addressing Global Warming Pollution in New Jersey

New Jersey must address global warming emissions from all sectors of the state's economy. Fortunately, there are many policy options that have the potential to curb global warming emissions in the state while boosting New Jersey's energy security and the long-term health of its economy. The policy suggestions that follow are not the only options available to the state, nor are they likely to be sufficient to reduce New Jersey's global warming emissions to levels consistent with preserving the global climate. But they do have the potential to reverse the trend toward rising global warming emissions in the state within the next decade and to put New Jersey on a trajectory toward further reductions in global warming pollution in the years to come.

Global Warming Strategies for New Jersey

New Jersey's Global Warming Leadership: Commitments Already Made

New Jersey has already begun to take action to head off future increases in global warming pollution. Over the past several years, the state has adopted or committed to adopt several measures that, if fully implemented, will reduce carbon dioxide emissions by as much as 11 percent versus projected levels by 2020. In the process, the state has established itself as a national leader in the effort to prevent global warming.

The ultimate success of these measures, however, is not a given. New Jersey has much work to do to ensure that the state's promising policy initiatives on global warming deliver real results.

Clean Cars Program

In 2004, the New Jersey Legislature adopted the Clean Cars Act, which commits the state to adopting stronger standards for automobile air pollution—including global warming pollution. The Clean Cars Program's global warming component alone will reduce global warming pollution by about 5.9 $MMTCO_2$ by 2020, or by about 4 percent versus projected statewide emissions.

New Jersey's Clean Cars Program is based on automobile emission standards adopted by the state of California. Since the 1960s, California has been a national leader in developing stronger emission standards for cars, due in part to its extreme air pollution problems. Recognizing California's unique problems and history of innovation, the U.S. Congress granted California the right to adopt its own vehicle pollution standards under the Clean Air Act. While other states with air pollution problems (like New Jersey) may not develop their own standards, they may adopt the more stringent standards in place in California.

In 2002, the California Legislature expanded the state's automobile emission control program to include emissions of global warming pollutants. The law required the California Air Resources Board (CARB) to propose limits that "achieve the maximum feasible and cost effective reductions 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 could not be imposed to attain the new standards.[66]

In September 2004, CARB adopted fleet average standards for global warming pollution that will reduce emissions from new cars by approximately 34 percent and emissions from new light trucks by 25 percent by 2016.[67] CARB estimates that adoption of the standards would lead to net consumer benefits of $3 per month for new car purchasers and $7 per month for light-truck buyers, with the higher cost of vehicles being more than offset by reductions in operating costs, primarily the cost of fuel.[68] The financial benefits are likely to be even greater now, due to higher gasoline prices.

The Clean Cars Program also includes a requirement that automobile manufacturers supply increasing quantities of "advanced technology" vehicles such as ultra-clean gasoline-powered cars and trucks, hybrid-electric vehicles, and eventually hydrogen fuel-cell vehicles. Many of these technologies have the potential to reduce global warming emissions dramatically in the decades to come.

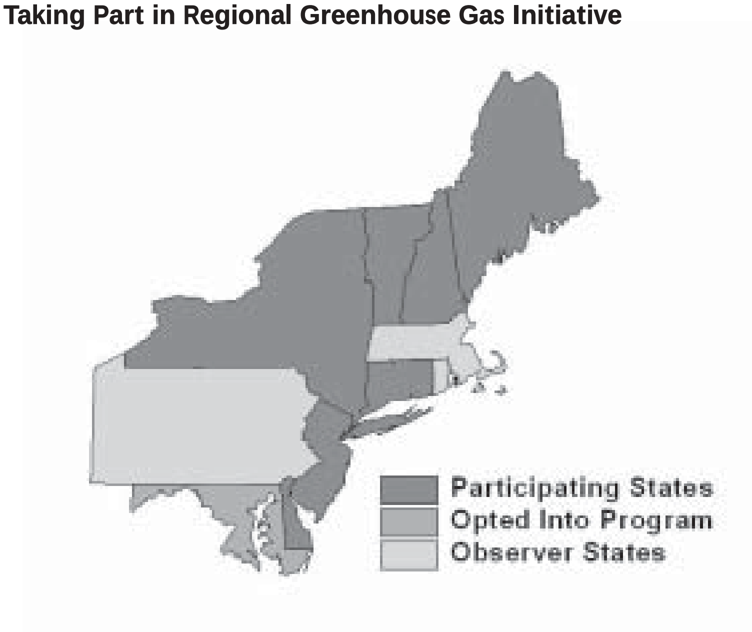
In 2006, California adopted a new law capping global warming emissions at 1990 levels by 2020, which translates into a 25 percent reduction in emissions from current levels.[69] The new law could lead California to pursue tighter limits on global warming emissions from vehicles beyond 2016.

The New Jersey Department of Environmental Protection (NJDEP) is currently in the process of implementing CARB's fleet average standards for global warming pollution and standards for the supply of "advanced technology" vehicles for New Jersey. New Jersey should fully implement the Clean Cars Program and work to defend the program against legal or political attacks from automakers and other powerful interests.

Regional Greenhouse Gas Initiative

In another pioneering effort, New Jersey recently teamed with seven other northeastern states to draw up the first regional "cap and trade" program for global warming emissions in the United States. Known as the Regional Greenhouse Gas Initiative (RGGI), the program will cap and then reduce emissions from electricity generators in the Northeast. Should the program be designed in such a way as to force emission reductions at electric power plants in New Jersey, the state could see reductions of as much as 10.4 $MMTCO_2$ versus reference case projections by 2020.

Fig. 9. States Taking Part in Regional Greenhouse Gas Initiative



Under RGGI, electricity generators will be required, starting in 2009, to hold permits (called "allowances") for each unit of carbon dioxide pollution they release to the environment. The number of allowances is fixed. If a company wishes to emit more pollution, it must buy additional allowances from companies that have succeeded in cutting their emissions.

Initially, the number of allowances issued annually will be capped at a level equal to projected 2009 emissions. The same number of allowances will be allocated each year through 2015. Between 2015 and 2019, the number of allowances issued will be reduced by 2.5 percent per year, such that emissions in 2019 are 10 percent below 2009 levels.[70]

New Jersey's initial emission target is set at approximately 20.8 $MMTCO_2$ in 2009, falling to 18.7 $MMTCO_2$ in 2019. Given that emissions from electricity generation in New Jersey are projected to increase significantly over the next two decades, achieving the RGGI target would represent a significant reduction in global warming emissions versus business-as-usual levels.[71]

However, the RGGI agreement and the draft model rule that has been developed to implement the program include a number of potential loopholes that could reduce the program's effectiveness in achieving its goals:

- **Offsets:** "Offsets" are emission reductions that take place at facilities that aren't covered by RGGI, but which can be used by RGGI participants to reduce the emission reductions they must make at their power plants. In theory, offsets allow companies covered by the program to achieve similar pollution reductions at lower cost if they can be had more cheaply elsewhere. In practice, however, offsets pose difficult enforcement challenges.[72] The RGGI program, as currently proposed, allows companies to cover up to 3.3 percent of their emissions with offsets. However, the program would also allow greater use of offsets if the price of an emission allowance exceeds a fairly low level ($7/ton).

  These provisions could allow for New Jersey power plants to maintain higher emissions than their RGGI target would otherwise allow, without sufficient guarantees that those higher emissions are matched by emission reductions elsewhere.

- **Circuit breakers:** The RGGI agreement includes a "circuit breaker" that would give facilities an extra year to comply with the carbon dioxide limits if the price of an allowance exceeds a relatively low level ($10/ton). While the circuit breaker is described as a way to protect electricity consumers, other measures (including the auctioning of emission allowances for public purposes rather than free distribution to generators) can deliver similar protections. The relatively low trigger price also reduces the incentive for power plant owners to make the investments necessary to achieve lasting reductions in carbon dioxide emissions and reduces the chances that New Jersey power plants will meet their RGGI targets.

- **Leakage:** RGGI will only help reduce global warming if it creates emission reductions in the aggregate and does not simply result in the transfer of emissions from RGGI states to power plants in states not covered by the program. Unfortunately, the RGGI rules, as currently written, do nothing to address "leakage" of emissions from New Jersey or other RGGI states to states not participating in the program. The RGGI states are now exploring options for the control of leakage in the program.

New Jersey deserves a great deal of credit for joining other northeastern states in putting forward the RGGI program. And the program, in part due to leadership from New Jersey, includes some cutting-edge elements, such as the allocation of some carbon dioxide allowances for public purposes, where the revenues from the sale of the allowances can be used to support energy efficiency or renewable energy programs or to defray some of the costs of the program for consumers. However, RGGI will only deliver on its promise of emission reductions if it is well designed. The state should use its position in the RGGI process to advocate for the closing of loopholes that would erode the carbon cap. By doing so, it can guarantee that the emission reductions promised by RGGI (and assumed in this analysis) will be achieved.

Clean Energy Standard

In 2006, the New Jersey Board of Public Utilities (BPU) adopted one of the strongest clean energy standards (technically referred to as the Renewable Energy Portfolio Standard) in the nation. The standard will require a gradual increase in the amount of renewable energy supplied to New Jersey electricity consumers, with the eventual goal of generating 20 percent of New Jersey's electricity from clean renewable power by 2020.[82] In addition, the standard will help to jump-start the installation of solar photovoltaic (PV) panels on New Jersey homes and businesses by requiring just over 2 percent of the state's power to come from solar by 2021, representing the largest solar "set-aside" program in the nation.

New Jersey's clean energy standard is one of the strongest and most forward-thinking in the nation, but there are ways in which its implementation could be improved. For example, under the clean energy standard, utilities can avoid compliance with the standard by making an "alternative compliance" payment to the state. The BPU should maintain the alternative compliance charge at a high enough level to provide a strong incentive for utilities to meet the goals of the standard, thus ensuring that utilities make the necessary commitment to encouraging the development of renewable energy in the state.

The development of renewable energy in New Jersey has also been aided by financial support through the BPU's New Jersey Clean Energy Program. Renewable energy projects already installed or planned as a result of funding from the program will generate 3.5 billion kWh of power over their lifetimes.[83]

Energy Efficiency Programs

New Jersey has also made strong strides toward improving the energy efficiency of the state's economy. In 2005, New Jersey adopted stronger energy efficiency standards for a variety of appliances, helping to build momentum for the inclusion of those standards in that year's federal Energy Policy Act. In addition, the state operates a number of ratepayer-supported energy efficiency efforts through the New Jersey Clean Energy Program. The Clean Energy Program is unusual among state energy efficiency efforts nationwide in that it focuses on reducing consumption of both natural gas and electricity. (Most state programs focus solely on electricity.) Energy efficiency improvements made through the program through 2005 will reduce consumption of electricity by 15.7 billion kilowatt-hours (kWh) over the lifetime of the measures.[84] In addition, the program will save about 389 million therms of natural gas over the lifetime of energy efficiency measures already installed.[85] The electricity and natural gas efficiency savings will ultimately reduce consumers' energy bills by nearly $2 billion.

The Clean Energy Program has been successful in promoting energy efficiency in New Jersey, but there remains room for improvement. Currently, the program supports both public and private sector projects with rebates, but there are other options for financing public-sector energy efficiency and renewable energy projects that might allow more Clean Energy Program funding to be devoted to private-sector efforts. Government agencies can often borrow money at rates more favorable than those available to private companies or individuals, creating the possibility of using the savings from energy efficiency measures to pay back the initial outlay.[86] In addition, government agencies face few of the non-monetary barriers to energy efficiency (such as split incentives between builders and building owners, lack of awareness of energy efficiency opportunities, and resistance to higher first-time costs) that affect the private sector. As a result, government agencies should not require large incentives from the Clean Energy Program to adopt energy efficiency measures.

The Future of Nuclear Power in New Jersey

About 48 percent of the electricity generated in New Jersey comes from the state's four nuclear power plants—Salem I and II, Oyster Creek and Hope Creek.[73] Three of these power plants (Salem I, II and Oyster Creek) will have their original operating licenses expire by 2025, with Oyster Creek's license set to expire first, in 2009. While the Nuclear Regulatory Commission (NRC) has been routinely approving 20-year license extensions for nuclear power plants across the country, the safety, security and environmental problems posed by New Jersey's nuclear power plants should lead to their closure at the end of their operating licenses.

Nuclear power poses a variety of public safety and environmental problems in New Jersey:

Safety: New Jersey's nuclear power plants have experienced a string of safety lapses over their lifetimes. In 2004, a pipe burst at the Hope Creek nuclear plant, resulting in the release of a small amount of radioactive steam into the turbine building.[74] In 2003, elevated levels of radioactive tritium were found in groundwater near the Salem I and II nuclear power plants, which are owned by the same utility as Hope Creek.[75] Both plants have experienced a variety of problems and a 2004 NRC investigation found that "there were numerous indications of weaknesses in corrective actions and management efforts to establish an environment where employees are consistently willing to raise safety concerns" at the three plants.[76]

Age-related corrosion has been a recurring problem at the Oyster Creek nuclear plant, the oldest operating nuclear power plant in the country. In 2004, an NRC investigation found that the plant's underground cables, which provide power to two back-up generators, failed three times—in 1996, 2001 and 2003—as a result of water intrusion and insulation degradation.[77] According to company documents provided in ongoing litigation, the Oyster Creek plant's steel drywell shell corroded from 1.154 inches to 0.603 inches between 1969 and 1992. Based on the company's own assessment, the shell is within less than 0.02 inches from failure, and could rapidly corrode to beyond current safety margins during a license extension period. Such corrosion could lead to collapse of the shell and a major accident in the worst-case scenario.

(continued next page)

By devoting more of its resources to improving the energy efficiency of New Jersey businesses and households, the Clean Energy Program could deliver greater energy savings and investments in renewable energy, enhancing the state's energy security and producing greater reductions in global warming emissions.

Cumulative Impact of Commitments Already Made

The four steps listed above have the potential to deliver significant reductions in global warming pollution in New Jersey versus projected levels. Assuming that the emission reduction targets of RGGI are met, that New Jersey achieves its goal of

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Thermal pollution and fish kills: Nuclear power plants, like other power plants that generate power with steam, consume large amounts of water, which is frequently discharged at elevated temperatures into streams, bays or ocean waters. A 1990 study conducted by Versar consultants on behalf of the New Jersey Department of Environmental Protection estimated that water intakes from the Salem I and II nuclear power plants resulted in four times more fish losses than the commercial fishing industry in the area. Damage to marine ecosystems from both the discharge of heated water and the entrapment of adult and juvenile marine animals has been documented in multiple cases across the country. In 2002, for example, discharge of heated water from the Oyster Creek nuclear power plant caused more than 5,000 fish to die from heat shock.[78]

Nuclear waste and terrorism: In the absence of a national repository for nuclear waste, spent nuclear fuel is typically stored in pools or casks on the grounds of the reactors, providing a potential target for terrorists and a potential safety threat. At the Oyster Creek power plant, for example, 960 metric tons of radioactive waste, equivalent to about 700 midsize cars, is stored in cooling ponds on the top of the five-story reactor building and in dry casks just 400 feet from Route 9.[79] Should coolant from spent-fuel pools be lost, the fuel could ignite, spreading highly radioactive compounds across a large area. In 2005, the National Academy of Sciences (NAS) warned that "[s]pent nuclear fuel stored in pools at some of the nation's 103 operating commercial nuclear reactors may be at risk from terrorist attacks," and recommended a series of actions to reduce the danger.[80] One study estimated that a loss of coolant accident that resulted in a spent-fuel pool catching fire could result in between 2,000 and 6,000 additional deaths from cancer.[81] The waste materials produced by nuclear power are also of potential interest both to terrorists and to nations that might want to produce nuclear weapons.

The energy efficiency and renewable energy policies described in this report not only help New Jersey to reduce its contribution to global warming, but can help reduce the state's dependence on its aging nuclear power plants. Indeed, the strategies listed in this report would likely eliminate the need for nuclear power from plants other than Hope Creek by 2016. (See "The Impact of the Strategies," page 47.)

By moving forward with a clean energy policy that emphasizes renewable energy development and improved energy efficiency, New Jersey can assure that it is able to serve its electricity needs without extending the lifetimes of its nuclear power plants and without adding new fossil fuel-fired generation that contributes to global warming.

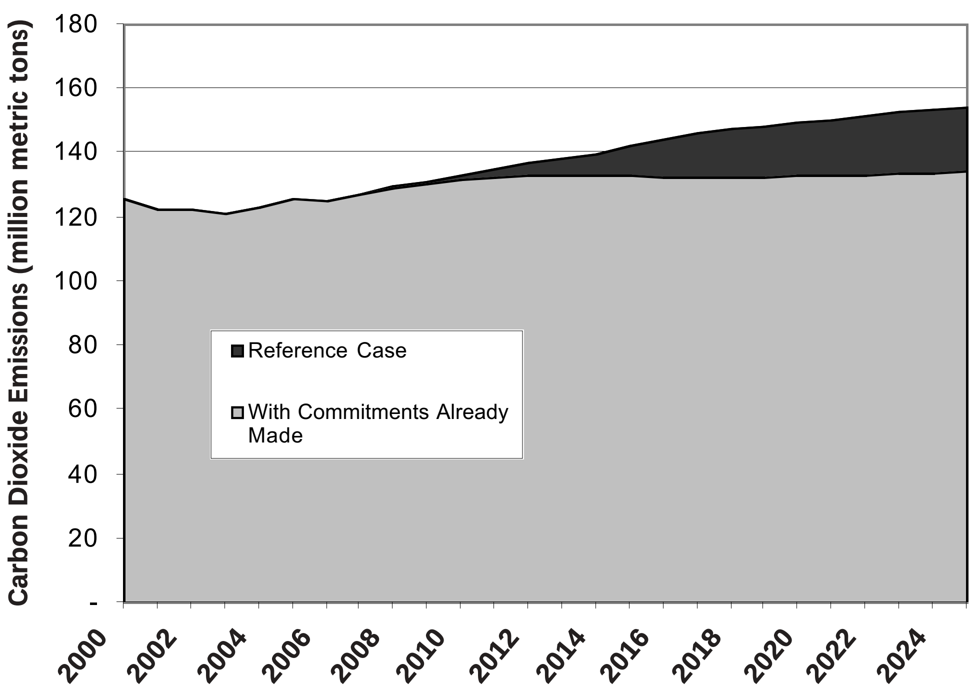
getting 20 percent of its electricity from renewable energy (with the amount of renewable energy generated inside the state proportional to the share of New Jersey's electricity generated in the state), that the Clean Cars Program is implemented on schedule, and that the Clean Energy Program continues to improve energy efficiency at the rate it does today, New Jersey can reduce its carbon dioxide emissions by nearly 17 $MMTCO_2$ below projected levels by 2020 and by nearly 19.7 $MMTCO_2$ by 2025. Instead of the projected 19 percent increase in carbon dioxide emissions over 2005 levels by 2020, emissions would increase by only 6 percent. (See Fig. 10.)

The good news for New Jersey is that the policy initiatives the state has already launched could, if fully implemented, halt the growth of carbon dioxide pollution in New Jersey by early in the next decade. But the state still faces major challenges in ensuring that its policy initiatives deliver results. And New Jersey must find additional strategies to achieve the significant reductions in carbon dioxide pollution that will be necessary to reduce the threat of global warming.

Strategies for Further Reducing Global Warming Emissions

New Jersey has many strategies that it can pursue to reduce global warming emissions. The following 11 strategies are among those the state can use to improve the energy efficiency of its economy and significantly reduce global warming emissions.

Fig. 10. New Jersey Projected Carbon Dioxide Emissions



Transportation Sector Strategies

1. **Require energy-saving tires.**
2. **Charge for automobile insurance by the mile.**
3. **Reduce the number of automobile commutes.**
4. **Reduce the growth in vehicle travel through smart growth and expanding transportation choices.**
5. **Improve freight rail infrastructure.**
6. **Encourage the federal government to increase fuel economy standards for cars.**

Strategy #1: Require Energy-Saving Tires

Potential Savings: 0.42 MMTCO_2 by 2010; 0.89 MMTCO_2 by 2020; 0.94 MMTCO_2 by 2025.

Energy efficiency standards for replacement tires can improve the fuel economy of the existing vehicle fleet at a net savings to consumers.

Automobile manufacturers typically include gasoline-saving low-rolling resistance (LRR) tires on their new vehicles in order to meet federal fuel economy standards. However, energy-saving tires are generally not available to consumers as replacements when original tires have worn out. As a result, vehicles with replacement tires do not achieve the same fuel economy as vehicles with original tires.

The potential savings in fuel and carbon dioxide emissions are significant. A 2003 report conducted for the California Energy Commission found that LRR tires would improve the fuel economy of vehicles operating on replacement tires by about 3 percent, with the average driver replacing the tires on their vehicle when the vehicles reached four, seven and eleven years of age. The resulting fuel savings would pay off the additional cost of the tires in about one year, the report found, without compromising safety or tire longevity.[87]

Several potential approaches exist for encouraging the sale and use of LRR tires —ranging from labeling campaigns similar to the federal Energy Star program to mandatory fuel efficiency standards for all light-duty tires sold in the state. California recently chose the latter approach, adopting legislation requiring that replacement tires sold to consumers beginning in July 2008 have the same average energy efficiency as the original tires provided by automakers.[88] The state will rate the energy efficiency of different tires based on testing information provided by manufacturers. The law does not require that each tire be labeled with its efficiency rating, but the information will be readily available to New Jersey to develop similar requirements.

A standards program that required the sale of LRR tires beginning in 2009 in New Jersey—assuming the same tire replacement schedules and per-vehicle emissions reductions found in the California study—would ultimately reduce carbon dioxide emissions from light-duty vehicles by about 2 percent by 2020, while also providing a net financial benefit to consumers through reduced gasoline costs.

Strategy #2: Implement Pay-As-You-Drive Automobile Insurance

Potential Savings: 1.47 MMTCO_2 by 2010; 2.14 MMTCO_2 by 2020; 2.20 MMTCO_2 by 2025.

Shifting the calculation of automobile insurance rates from a flat annual rate to a per-mile basis would encourage car owners to drive fewer miles and reduce global warming pollution.

In a perfectly functioning market, the rates individuals pay for automobile insurance coverage would accurately reflect the risk they pose to themselves and others. Insurers currently use a host of measures—including vehicle model, driving record, location and personal characteristics—to estimate the financial risk imposed by drivers.

One measure that is strongly linked to automobile safety and yet is not used with much accuracy in the calculation of insurance rates 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.[89] Many insurers do provide low-mileage discounts to drivers, but these discounts are often small, and do not vary based on small variations in mileage. For example, a discount for vehicles that are driven less than 7,500 miles per year does little to encourage those who drive significantly more or less than 7,500 miles per year to alter their driving behavior. As a result, the system fails to effectively encourage drivers to reduce their risk by driving less.

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

A pay-as-you-drive (PAYD) system of insurance in New Jersey 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 related to mileage (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 adjustments of premiums based on actual mileage taking place at the end of the year. Of critical importance to the success of the system would be the creation of accurate, convenient methods of taking odometer readings and communicating them to the insurer.

A pay-as-you-drive system of insurance would have broad benefits for New Jersey —not only for reducing global warming pollution, 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, research indicates that a mileage-based insurance system would reduce driving. Converting the average collision and liability insurance policy to a per-mile basis in New Jersey would lead to an average insurance charge of about 9.5 cents per mile.[90] (For comparison, a driver buying gasoline at $2.50 per gallon for a 20 MPG car pays 12.5 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, reducing vehicle-miles traveled by about 5 percent below projected levels, with carbon dioxide emissions from light-duty vehicles declining by roughly the same amount.[91]

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.[92]

New Jersey should consider moving

toward a system of PAYD insurance, perhaps by first 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.

Strategy #3: Reduce the Number of Automobile Commutes

Potential Savings: 1.64 $MMTCO_2$ by 2010; 2.87 $MMTCO_2$ by 2020; 2.95 $MMTCO_2$ by 2025.

Commutes to and from work make up a major share of vehicle travel in New Jersey. Nationally, about 28 percent of all vehicle miles are traveled on the way to or from work.[93] Programs that require employers to provide transportation alternatives to their employees can go a long way toward reducing the number of vehicle-miles traveled on New Jersey's highways.

Mandatory commute-trip reduction programs were tried briefly in New Jersey during the early 1990s. The 1990 federal Clean Air Act required employers in states with severe air pollution problems—including New Jersey—to develop employer trip-reduction programs designed to achieve a 25 percent improvement in the average vehicle occupancy of vehicles arriving at worksites. The law applied to companies with more than 100 employees working at a single worksite.[94] New Jersey initially adopted a law implementing the requirement, but mandatory trip reduction efforts met with opposition from business interests both in Washington, D.C. and in Trenton. By 1996, the mandatory aspects of both the federal and state trip-reduction laws had been repealed, and employer trip-reduction efforts were made purely voluntary.

Nevertheless, some New Jersey employers have continued to offer programs designed to reduce single-passenger commuting, with support and assistance from the New Jersey Department of Transportation. Such programs typically provide incentives for workers to carpool, vanpool, use public transportation, telecommute or travel during non-peak hours. In some cases, employers within a particular geographic area have banded together in transportation management associations to provide transportation options to their workers.

For many of these companies, commute-trip reduction programs make good business sense by improving employee morale, providing a desirable benefit for prospective employees, and reducing expenditures for parking. But the evidence suggests that mandatory trip-reduction programs—particularly those in which government plays a strong supporting role in helping employers achieve their commute-trip reduction goals—are more effective than voluntary efforts in bringing about large reductions in single-passenger commutes.

Between 1990 and 2000, for example, the percentage of New Jersey workers driving to work alone increased from 75.1 percent to 76.7 percent, in line with the national trend.[95] Only two states experienced a decrease in the percentage of drive-alone commuters during the 1990s—Washington and Oregon. Not coincidentally, those two states also have effective mandatory employer trip reduction programs.

Washington State's program was enacted in 1991 and covers employers with 100 or more full-time employers at a single worksite in the state's nine most populous counties. The program requires employers to develop plans designed to reduce vehicle-miles traveled by employees in line with a set of increasingly stringent targets.[96] Oregon's program applies to employers with 50 employees or more at a single site in the Portland metropolitan area. It requires employers to offer incentives for the use of commuting alternatives with the potential of reducing commute trips by 10 percent over three years.[97]

Both programs have achieved results in

reducing commuting travel. The Washington program removes 19,000 vehicles from the state's highways each morning, and the rate of single passenger commuting at worksites covered by the program dropped from 70.8 percent in 1993 to 65.7 percent in 2003. The number of commuting vehicle-miles traveled at those facilities would have been 5.9 percent higher were it not for the program. The Washington program also reduces global warming pollution by about 74,000 tons per year.[98] Oregon claims that 30 percent of employers in its program are meeting the 10 percent reduction target, and another 35 percent have seen trip reductions of between 1 and 9 percent, producing an annual reduction in vehicle-miles traveled of 35.4 million.[99]

A vigorous, mandatory trip reduction program for New Jersey employers could achieve similar, if not better results. New Jersey's history of voluntary trip-reduction efforts, coupled with the state's extensive transit infrastructure, could provide a solid foundation for the expansion of trip-reduction efforts.

The carbon dioxide emission reductions projected for this strategy assume that large employers in the state (those with more than 100 employees) can reduce the number of single-passenger commuting trips by 40 percent by 2012. Among the programs and measures that can be used to achieve that goal are the following:

- Incentives and preferential parking privileges for carpool and vanpool drivers.
- Shuttle service to nearby transit stations.
- Programs to encourage and facilitate telecommuting.
- Flexible work schedules that allow workers to commute fewer days of the week.
- Parking "cash out," which allows employees to receive the value of employer-provided free parking for other uses if they choose not to drive to work.
- Emergency ride home programs that ensure that workers using transit are not stranded if they need to work late or return home early.
- Providing secure bicycle storage and changing facilities for employees who bike to work.
- Reimbursing bicycle and transit mileage for business trips when those modes are comparable in speed to driving.
- Creating a trip-reduction coordinator and actively promoting commuting benefits to employees.

In implementing an aggressive trip-reduction program, New Jersey should be sensitive to the concerns of the business community—particularly those businesses that have already invested in voluntary commute trip-reduction efforts. Washington state's program, for example, includes businesses and local governments in the governance of the program, resulting in strong partnerships that enhance the program's success.

In addition, New Jersey should be prepared to invest in helping businesses meet their commute-trip reduction goals. Commute-trip reduction has proven to be an extremely cost-effective way to reduce highway congestion, energy use and air pollution—in Washington state, for example, $2.7 million in annual investment from the state has delivered more than $37 million in reduced fuel expenditures and travel delay alone.[100] A relatively small investment of state funds, if coupled with a mandatory trip-reduction effort, could yield large dividends in reduced global warming emissions, reduced congestion, and reduced dependence on petroleum.

Strategy #4: Reduce Growth in Vehicle Travel Through Smart Growth and Expanded Transportation Choices

Potential Savings: 1.52 $MMTCO_2$ by 2010; 5.23 $MMTCO_2$ by 2020; 6.82 $MMTCO_2$ by 2025.

The growth in vehicle-miles traveled (VMT) over the last several decades has its roots in many societal changes—rapid population growth in New Jersey, low gasoline prices, expansion of the workforce, and residential and commercial suburban sprawl.

Reversing this trend will be challenging, but success would bring benefits not only in reducing global warming emissions but also in easing traffic congestion, reducing public expenditures on highways, enhancing New Jersey's energy security, and reducing automotive emissions of other pollutants that harm public health. The emission reductions projected for this strategy assume that New Jersey can hold per-capita vehicle-miles traveled steady over the next two decades—or, in other words, that VMT would increase only at the rate of population growth. Even more aggressive reductions in vehicle travel may be possible in the future.

Stabilizing per-capita vehicle-miles traveled at today's levels would avoid a large projected increase in vehicle travel over the next two decades. By stabilizing per-capita travel, the number of vehicle miles traveled in New Jersey would increase by only about 11 percent between 2004 and 2025, compared with an approximate 32 percent increase in the reference case scenario.[101]

New Jersey residents have already begun to cut back on driving as a result of higher fuel prices. Data from the Federal Highway Administration indicate that 0.6 percent fewer vehicle miles were driven on New Jersey highways in 2005 versus 2004.[102] Transit ridership has increased dramatically, with NJ Transit reporting record ridership in fiscal year 2005.[103] For 2005 as a whole, ridership on NJ Transit and Port Authority transit services was up by more than 4 percent from the year before.[104]

The increase in transit use in New Jersey is a testament to the efforts made over the last decade to improve the quality of transit service in the state and to encourage transit-oriented development. Construction of new transit lines such as the Hudson-Bergen Light Rail Line and RiverLine, establishment of better transit connections (such as Midtown Direct commuter rail service and the state's novel community shuttle program), and a recent emphasis on the development of Transit Villages have contributed to the increase in transit ridership and have the potential to bring about further shifts in the years ahead.

New Jersey should continue the momentum toward more compact growth based around access to transit, while simultaneously dealing with other challenges.

- **Restraining exurban sprawl** – New Jersey has focused a great deal of effort on the revitalization of urban areas and the creation of Transit Villages. Continuing to encourage the location of jobs and economic activity around transit stops is a critical strategy for promoting sensible, transit-accessible growth. But while these efforts are beginning to make an impact, the growth of "exurbs" in the far reaches of the state continues. Rapid population growth in the state's central counties, the Highlands of North Jersey, and even in eastern Pennsylvania threatens to bring even more traffic to New Jersey's highways and to exacerbate global warming through longer commutes. New Jersey should work with municipalities and neighboring states to ensure that new growth takes place in a way that minimizes demand for highway travel and to encourage growth in already built-up areas with transportation infrastructure.
- **Keep transit fares reasonable** – New Jersey benefits from one of the nation's

most extensive transit networks, and with gasoline prices at or near record levels, more New Jersey residents are looking for alternatives to their automobile commutes. Unfortunately, NJ Transit fares have been on the rise as well. Last year, NJ Transit riders sustained a 10 percent fare hike and another 7 percent hike is possible.[105] Fare hikes can price out riders at the bottom of the income spectrum while discouraging long-distance automobile commuters from using transit instead. Rather than increasing fares yet again, state leaders should use the opportunity posed by higher gasoline prices to encourage new transit ridership by stabilizing (and, if possible, reducing) transit fares.

- **Expand access to transit** – New Jersey has recently made important additions to its transit network, but further expansions in transit availability—as well as improvements in the frequency and quality of service—will be needed to expand New Jerseyans' range of transportation choices and provide alternatives to automobile use.
- **Integrate smart growth, climate policy and transportation planning** – Transportation investments have impacts that go well beyond addressing specific traffic problems. They influence patterns of future land development and have a large environmental impact. Transportation planners in New Jersey have begun to integrate these larger impacts into their evaluation of transportation projects, in some cases working with local citizens and municipalities in "corridor studies" that evaluate transportation problems within the broader context of land use and community development. The state should continue to move toward such an integrated approach, both in the evaluation of local projects and in statewide planning efforts. In addition, the state should ensure that "transportation demand management" measures —which often reduce the need for new capital expenses by better managing travel demand—are considered and evaluated alongside any proposals for new transportation infrastructure. Finally, the state should include a consideration of the impact on global warming emissions of all new transportation projects, so that New Jersey residents can evaluate the impacts of various transportation choices on the climate.

By continuing to focus on the development of vibrant, compact communities whose residents have access to a variety of convenient, affordable transportation options, New Jersey can stabilize the growth of vehicle travel, while reducing congestion on the state's highways and curbing the state's dependence on oil. The state should set a goal of stabilizing per-capita vehicle travel and develop transportation and land use policies sufficient to meet that goal.

Strategy #5: Improve New Jersey's Freight Rail Infrastructure

Potential Savings: 1.38 MMTCO_2 by 2020; 2.52 MMTCO_2 by 2025.

Truck traffic clogs New Jersey highways, produces vast amounts of pollution (including both global warming pollution and health-threatening smog and soot), and adds to the maintenance bill for New Jersey highways. Trucks currently account for about 8.8 percent of total travel on New Jersey's highways, and that percentage is expected to increase to more than 10 percent by 2020—with truck traffic projected to increase by an astounding 80 percent within the next two decades.[106]

There is a more energy-efficient way to transport freight around and through New Jersey than in trucks. Rail transport is a far more energy efficient way to move goods than by truck, taking about one-tenth the amount of energy.[107] In New Jersey, however, the vast majority (79 percent within the state and 60 percent traveling to or from the state) of freight travel goes by truck.[108]

Why doesn't more freight travel in New Jersey by rail? In part it is because much of the state's (and region's) rail infrastructure is outmoded. A recent study by a mid-Atlantic regional consortium identified numerous "choke points" in the region's rail system that reduce the system's capacity for carrying freight and passengers. Among those choke points are antiquated or undersized bridges and tunnels, limited track capacity, and lack of necessary connections between lines.[109]

The consortium's report recommended a $6.2 billion investment in the mid-Atlantic region's rail system. By making that investment, the consortium concluded, the percentage of freight traveling through the region could approach the national average—eventually taking 25 percent of the trucks projected to travel the region's highways off the roads.[110] The emission reductions projected above assume that the region makes investments in rail and associated infrastructure sufficient to replace 25 percent of New Jersey's projected truck traffic with freight rail shipments.

New Jersey should participate in cooperative efforts with the railroads, other states and the federal government to improve the region's freight rail infrastructure

Financial Incentives for Vehicle Efficiency

New Jersey can drive further reductions in global warming pollution from cars, light trucks and SUVs by establishing a program to provide financial incentives for the purchase of low-polluting, high-efficiency vehicles.

An effective incentive program would couple rebates to car buyers who purchase lower carbon dioxide-emitting vehicles (which tend also to be more fuel-efficient) with fees on purchasers of higher-emitting vehicles. By pairing fees and rebates, the program could be designed to be revenue-neutral for the state (thus requiring no additional tax expenditures) and could encourage greater shifts away from gas-guzzlers and toward more efficient cars.

There are many ways to design such a combined fee and rebate (or "feebate") program. The program can cover all vehicle sales—with the fees and rebates set on a sliding scale based on fuel economy—or assess fees only to buyers of the worst gas-guzzlers and provide rebates only to purchasers of the most fuel-efficient cars. In order to be effective, the program would have to provide financial incentives strong enough to influence consumer behavior, and cover enough vehicles to encourage automakers to provide consumers with more options of highly efficient vehicles. While no state has yet implemented a feebate program, several are considering doing so as part of their efforts to reduce global warming emissions from vehicles.

Emission reductions from feebate programs are difficult to estimate, particularly in states like New Jersey that have adopted California's vehicle global warming emission standards. However, adoption of a feebate program would provide yet another tool for New Jersey to use in promoting a shift toward vehicles with less impact on the global climate.

over the next two decades and encourage businesses to shift from truck to rail transport of freight wherever feasible.

Strategy #6: Push for an Increase in Federal Fuel Economy Standards for Cars and Light Trucks

Potential Savings: 0.88 $MMTCO_2$ by 2010; 8.62 $MMTCO_2$ by 2020; 11.41 $MMTCO_2$ by 2025.

The most effective tool for reducing global warming emissions from transportation is also one that is out of the hands of New Jersey state officials: increasing federal fuel economy standards for light-duty vehicles to 40 miles per gallon (MPG) or more. Federal law prohibits states from adopting their own fuel economy standards for vehicles, but New Jersey can urge the federal government to adopt stronger standards and take other actions to encourage improvements in vehicle fuel economy.

Increasing federal fuel economy standards to 40 MPG is both technologically feasible and likely to save consumers money. The Union of Concerned Scientists (UCS) has concluded that average vehicle fuel economy of 40 MPG is attainable within a 10-year timeframe, even without the widespread use of hybrid technology. In addition, UCS concluded that such standards would provide a net savings to purchasers of more-efficient light trucks, even given a relatively conservative estimate of gasoline prices ($1.75 per gallon).[111] Similarly, the Consumer Federation of America concluded that a 50 MPG standard would be both feasible and cost-effective by 2030, assuming gasoline prices of $3 per gallon, using technologies that are either currently available or projected to be available soon.[112]

Most of the technologies used to achieve the fuel economy improvements and global warming pollution reductions described above are neither new nor exotic. Technologies such as six-speed automatic transmissions, continuously variable transmissions, turbocharging and cylinder deactivation are already finding their way into growing numbers of vehicles. Other more advanced technologies, such as improved electrical systems and idle-off (in which the gasoline engine is shut off during idling), can also significantly reduce emissions.

Unfortunately, American consumers have had very limited choice of fuel-efficient vehicles. According to the EPA, there were only 42 model year 2006 vehicle models that achieved 30 MPG combined city/highway mileage or greater (compared with more than 400 models that achieved less than 20 MPG combined). Of those 42 vehicles, 27 were compacts, subcompacts or other small cars. Only three mid-sized cars, no mid-sized station wagons, and six SUV models achieved 30 MPG or greater.[113]

Improving the fuel economy of light-duty vehicles reduces the per-mile emissions of global warming pollutants from vehicle tailpipes. By adopting the Clean Cars Program, with its limits on tailpipe global warming pollution, New Jersey has already taken an important step in the right direction. A 40 MPG fuel economy standard, however, would deliver reductions above and beyond those possible under the program.

The emission reductions projected for this scenario are based on a gradual increase in federal fuel economy standards beginning in 2009 and culminating in a 40 MPG standard for both cars and light trucks in 2018.

The state of New Jersey should urge Congress and the Bush administration to strengthen federal fuel economy standards. In addition, the state should consider ways in which it can promote improved fuel economy through measures other than standards—for example, through financial incentives for purchasers of highly efficient vehicles coupled with penalties for purchases of gas-guzzlers. Finally, the state should urge the federal government to create fuel economy standards for heavy-duty trucks, which are responsible for a sizeable share of transportation global warming emissions in New Jersey.

Heavy-Duty Truck Fuel Economy

Heavy-duty trucks are major consumers of fuel. Large tractor-trailers consumed about 14 percent of the fuel used by all highway vehicles nation ally in 2004, and fuel consumption by large trucks has been increasing by more than 4 percent per year since the early 1990s.[114] As is the case with the light-duty vehicle fleet, fuel economy among the largest trucks has also been declining, dropping 5 percent between 1997 and 2002.[115]

Heavy-duty trucks are exempt from federal fuel economy standards. But significant increases in fuel economy for these trucks are possible at a net lifetime savings to vehicle owners. A 2004 study conducted by the American Council for an Energy-Efficient Economy (ACEEE) found that fuel economy improvements for tractor-trailers of 58 percent are achievable and cost-effective. The study also identified cost-effective improvements in fuel economy for other types of large trucks.[116] Calculations of cost-effectiveness were based on diesel fuel prices of $1.41 to $1.60 per gallon, well below the recent prices of $2.80 and higher charged recently at pumps across the United States.[117] As a result, the ACEEE estimates of cost-effective savings are likely conservative.

Imposing federal fuel-economy standards designed to increase the fuel economy of tractor-trailers by 50 percent would significantly reduce global warming pollution from the fast-growing freight transportation sector. The increase would be sufficient to raise the average fuel economy of heavy-duty trucks from approximately 5.7 MPG to about 8.5 MPG. The United States should also devise strategies to reduce fuel consumption and promote energy-efficient technologies in all medium- and heavy-duty trucks.

Residential, Commercial and Industrial Sector Strategies

7. Significantly strengthen residential and commercial building energy codes.

8. Adopt significantly stronger energy efficiency standards for appliances.

9. Establish a strong state energy efficiency goal and expand state energy efficiency programs.

10. Expand combined heat and power.

Strategy #7: Strengthen Residential and Commercial Building Energy Codes

Potential Savings (Direct Emissions Only – see "Calculating Global Warming Benefits from Electricity Savings," page 43): 0.08 MMTCO_2 by 2010; 1.02 MMTCO_2 by 2020; 1.40 MMTCO_2 by 2025.

New Jersey is a leader in many areas of clean energy policy, but in one area the state has lagged: the adoption and enforcement of strong building energy codes. Building codes were originally intended to ensure the safety of new residential and commercial construction. In recent years, however, building codes have been used to reduce the amount of energy wasted in heating, cooling, lighting and the use of electrical equipment.

New Jersey is significantly behind most East Coast states in its adoption of building energy codes. The current residential code is based on the 1995 Model Energy Code (MEC), while the commercial code is based on the American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 90.1-1999 code.[118] Many other East Coast states have adopted the most recent commercial and residential building codes, issued in 2004. (A new version of the International Energy Conservation Code, or IECC, was released in early 2006.)

In New Jersey, there is already a strong market for highly efficient homes and commercial structures. In 2004, 16 percent of new homes in New Jersey were certified as "Energy Star" homes, which consume 30 percent less energy than homes built to the 1993 MEC standard.[119] New Jersey certifies far more homes to Energy Star standards than the national average—only 6 percent of new homes nationally met Energy Star standards in 2003, compared to 15 percent in New Jersey that year.[120]

Building energy codes are important, however, as they set a "floor" for energy efficiency in all new construction (and major renovations of existing structures). Failing to maintain and enforce the strongest building energy codes available results in lost opportunities for energy savings. And since residential and commercial buildings can last for decades, those lost opportunities can result in excessive energy consumption over the long term.

The global warming emission reductions projected here assume that New Jersey adopts the IECC 2004 residential code and the most recent commercial building energy code in 2007. On the residential side, we assume that New Jersey adopts a residential energy code equivalent to the current Energy Star homes standard in 2010. And on the commercial side, we assume that energy codes capable of reducing energy consumption by 25 percent from the current code are adopted effective in 2010.

In addition to setting a higher "floor" for building energy efficiency, New Jersey can also take steps to raise the bar for exceptional energy efficiency performance. Continuing to encourage builders to construct homes meeting Energy Star standards is a start, as is ensuring that all new government buildings and renovations to existing buildings meet high energy efficiency standards. (See "Government Lead by Example," page 46.) New Jersey should also encourage the development of "zero energy" homes and commercial buildings, which pair strong energy efficiency measures with small-scale renewable energy production to dramatically reduce, or even eliminate, fossil fuel consumption.

Strategy #8: Adopt Strong Appliance Efficiency Standards

Potential Savings (Direct Emissions Only): 0.24 MMTCO_2 by 2020; 0.37 MMTCO_2 by 2025.

Many appliances that New Jersey homeowners and businesses use can be made to be significantly more energy efficient than they are today. New Jersey has the power to adopt energy efficiency standards for a range of residential and commercial appliances. The standards can save New Jersey consumers money over the long haul and reduce the state's consumption of energy.

In 2005, New Jersey helped pave the way for stronger national appliance efficiency standards by adopting standards for a variety of household and commercial appliances including torchiere lamps, exit signs, traffic signals and commercial air conditioners. The adoption of state standards by New Jersey and other states led the U.S. Congress to include federal energy efficiency

Calculating Global Warming Benefits of Electricity Savings

The global warming emission reductions resulting from policies that save electricity depend on the type of electricity generation that is displaced. New Jersey's electricity comes from some generators that produce large volumes of carbon dioxide pollution per unit of electricity produced (such as coal-fired power plants), those that produce fewer emissions (such as newer natural gas-fired plants), and those that produce minimal carbon dioxide (e.g. renewable energy).

In addition, emission reductions from electricity savings depend on how various public policies interact. For example, New Jersey is a part of a regional agreement to cap global warming emissions from electricity generation. (See "Regional Greenhouse Gas Initiative," page 27.) As such, electricity generators will need to reduce their carbon dioxide emissions below the cap level, regardless of the level of electricity demand within the state.

In presenting carbon dioxide savings from the individual policy scenarios in this report, we do not include any reductions from avoided electricity use. We assume instead that reductions in the demand for electricity are first used to reduce the need for nuclear power generation in New Jersey. Several of the state's nuclear reactors are scheduled to reach the end of their useful lives over the next two decades and will need to be replaced either through reductions in demand for power or new sources of generation. None of the individual energy-saving policies detailed in this report are sufficient to offset all the power generated from nuclear power plants that are scheduled for shutdown by 2025.

In addition, in the combined policy case presented at the end of this report (see "The Impact of the Strategies," page 47), emissions from the electricity sector are determined by the emission target assigned to New Jersey under the Regional Greenhouse Gas Initiative. While it is possible that the energy efficiency and renewable energy strategies listed here, when combined, would produce emission levels below the RGGI target under certain assumptions (for example, that all electricity savings be used to reduce coal-fired power generation in New Jersey), our scenario, which is described in the Methodology section of this report, does not produce this result.

However, policies that save electricity, while they may not generate emission reductions beyond the level of the cap using the assumptions in this report, certainly provide other benefits by allowing New Jersey to retire its nuclear generating units at the end of their current operating licenses (see page 48), and reducing the additional cost of complying with the RGGI emission targets.

standards for 15 new appliances in the 2005 Energy Policy Act.

However, new energy efficiency technologies for appliances continue to be developed and New Jersey has an opportunity to adopt stronger standards for appliances that were not covered in the 2005 law. Appliances for which new standards would be appropriate, either now or in the near future, include:

- DVD players and recorders
- External power supplies for consumer electronics
- Compact audio products
- Residential furnaces and boilers
- Commercial hot food holding cabinets, walk-in refrigerators and freezers
- Bottle-type water dispensers[121]

Most of the appliances for which new standards are appropriate are not currently covered under federal standards. As a result, New Jersey has the ability to impose its own standards. For products that are currently covered under outdated federal standards, New Jersey may apply for a federal waiver to apply stronger energy efficiency standards.

The American Council for an Energy Efficient Economy (ACEEE) and the Appliance Standards Awareness Project (ASAP) estimate that adopting a new set of recommended appliance efficiency standards in New Jersey would reduce electricity demand by 2,137 gigawatt-hours (GWh) in 2030, reduce natural gas demand by 8,031 million cubic feet, and save New Jersey more than $2 billion over time.[122]

The emission reductions estimated for this scenario assume that New Jersey adopts all of the efficiency standards recommended by ACEEE and ASAP. Further reductions will be possible in future years as new technologies allow appliance efficiency standards to be tightened over time.

New Jersey should move ahead with the adoption of efficiency standards for appliances not covered by federal rules and apply for waivers of pre-emption for others. In addition, the state should allow for the expedited adoption of future appliance standards set by large states, such as California, enabling New Jersey to stay on the cutting edge of energy efficiency and achieve further reductions in global warming pollution in the years ahead.

Strategy #9: Establish an Energy Efficiency Goal and Expand Energy Efficiency Programs

Potential Savings (Direct Emissions Only): 0.12 MMTCO$_2$ by 2010; 0.44 MMTCO$_2$ by 2020; 0.57 MMTCO$_2$ by 2025.

New Jersey's Clean Energy Program has succeeded in generating significant energy efficiency improvements for the state at reasonable cost. (See page 29.) However, studies of New Jersey's energy efficiency potential, combined with the experience of energy efficiency programs in other states, suggest that there is much more that can be done to make New Jersey more energy efficient.

New Jersey should set an aggressive goal for improving the energy efficiency of the state's economy and adopt policies and allocate resources sufficient to meet that goal. Such a goal should be designed to capture as much of the state's cost-effective energy efficiency potential as possible. We do not suggest a specific goal for the state to reach, but expanding the state's current energy efficiency efforts by doubling the funding of the Clean Energy Program would put the program on a financial par with the most successful energy efficiency programs in the country and allow New Jersey to tap much of the state's potential for energy savings.

A recent study suggests that New Jersey could reduce its electricity consumption by 17 percent and its natural gas consumption by 30 percent by 2020 at a net benefit to the state's economy.[123] The study also found that a "business as usual" scenario with energy efficiency spending remaining at current levels would result in only a portion of those efficiency savings being captured. Roughly doubling spending on energy efficiency programs could lead to additional net benefits of $1.4 billion to the state.[124]

Some states already invest in energy efficiency at a higher level than New Jersey. New Jersey ranked eighth for per-capita spending on electric energy efficiency programs in 2003, down from fourth three years earlier.[125] Vermont, the nation's leader in energy efficiency spending, invested more than twice the amount of money in energy efficiency per capita than did New Jersey in 2005.[126] Vermont has benefited from that extra investment—the state's rate of electricity demand growth is less than half of what it would have been without energy efficiency programs, slashing Vermont's electricity consumption by close to 5 percent in 2005.[127]

The New Jersey Board of Public Utilities (BPU) has already authorized additional funding for energy efficiency programs, approving a 29 percent increase in funding between 2005 and 2008.[128] Doubling funding for New Jersey's existing electricity and natural gas efficiency programs above the levels proposed by the BPU and maintaining that funding over the next two decades would help the state come closer to realizing its full, economically beneficial level of energy efficiency—delivering both reductions in global warming emissions and long-term cost savings to New Jersey consumers.

Strategy #10: Expand Use of Combined Heat and Power

New Jersey has many opportunities to promote the use of combined heat and power, in which wasted energy from electricity generation is captured and used for other purposes.

America's electricity system is a good source of reliable power, but it also loaded with inefficiencies. Power plants produce a large amount of waste heat during their operation. Similarly, the nation's long-distance transmission system results in the loss of between 5 and 10 percent of the electricity that crosses the wires on its way from power plants to homes and businesses.[129]

New Jersey could reduce energy waste by promoting the use of combined heat and power (CHP) systems. CHP systems pair electricity generation and heating—enabling the waste heat from electricity generation to be used to provide space or water heating or to assist in industrial processes. While the average American power plant operates at a thermal efficiency of about 35 percent, CHP plants can achieve efficiencies of 80 percent or greater, meaning that more of the energy that goes into the plant is available for useful work.[130]

Various forms of CHP are already in use in New Jersey, accounting for nearly 3,500 megawatts of generation capacity.[131] CHP can be implemented at the scale of a single industrial facility, in which a factory generates its own power and heat, or at the scale of a neighborhood, college campus or downtown area, where the steam or hot water from a power plant is used to provide space heating to multiple buildings. A 2004 analysis of markets for large-scale CHP identified several industries—including pharmaceuticals, chemicals and food production—that are both well-suited to CHP and have a major presence in New Jersey.[132]

Despite the large amount of CHP capacity already present in New Jersey, a major expansion of capacity is possible. New Jersey has the technical potential for another 3,200 MW of CHP capacity.[133] A 2004 report found that, with aggressive policy action, including rebates for installation of CHP capacity, New Jersey could develop more than 2,100 MW of new CHP capacity in the commercial and industrial sectors by 2020.[134]

Because CHP systems use fossil fuels, it is important that they are designed in such a way as to maximize their global warming emission reductions and energy savings and minimize air pollution. CHP plants should be required to meet minimum energy efficiency targets and include state-of-the-art air pollution controls.

There are no direct carbon dioxide emission reductions associated with the expansion of CHP in New Jersey, since deployment of CHP will tend to increase on-site consumption of natural gas, while offsetting the consumption of fossil fuels for the generation of electricity in central power plants.

Other Strategies to Reduce Global Warming Pollution

Strategy #11: Government "Lead By Example"

Potential Savings: 0.28 $MMTCO_2$ by 2010; 0.74 $MMTCO_2$ by 2020; 0.78 $MMTCO_2$ by 2025.

State and local governments are large users of energy in New Jersey. The state government alone spends about $128 million annually on energy costs.[135] Reducing energy use in the government sector not only has a direct impact on global warming pollution; it also sets an example for the private sector as to what can be achieved.

New Jersey state government is already taking strides toward reducing its consumption of energy and contribution to global warming. In April 2006, Gov. Jon Corzine issued an executive order establishing the position of Director of Energy Savings and outlining a number of steps the state government will take to reduce its consumption of energy. Specifically, the order calls for:

- Energy audits at state buildings designed to identify cost-effective energy efficiency and renewable energy investments.
- Bulk energy purchases.
- Development of a plan for promoting economic development around clean energy technologies.
- Reviewing the state vehicle fleet to assess the possibility of purchasing more efficient vehicles.
- Requiring the use of Energy Star products in state agencies.[136]

Ideally, this new effort should lead to the development of specific goals and targets for reducing state government energy use. The state should also engage in efforts to help municipal governments and public institutions (such as colleges and universities) improve their energy efficiency.

The state has also met with success in its efforts to expand its purchases of "green power." In 2003, New Jersey planned to purchase 12 percent of its power from renewable sources.[137]

Specific targets the state should aspire to achieve include the following:

- A 25 percent reduction in energy consumption in government buildings statewide;
- A 50 percent reduction in energy consumption from new government buildings;
- Government purchases of at least 40 percent renewable energy;
- Replacing government vehicles with the most efficient vehicles available.

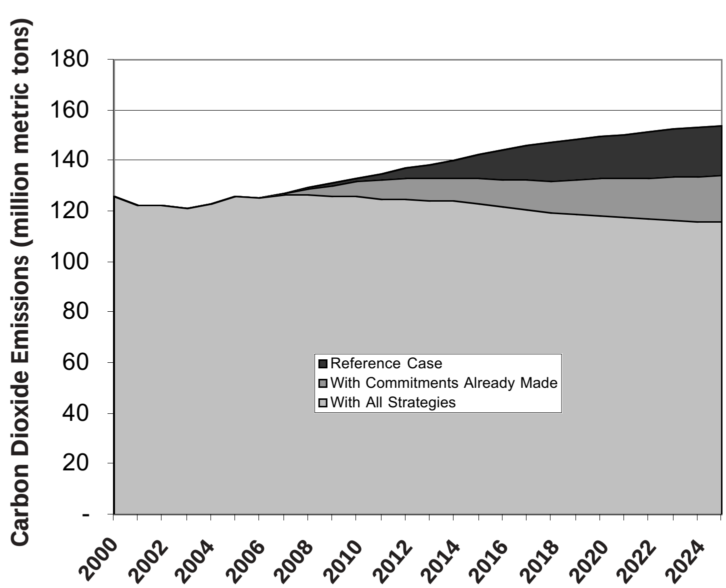
These goals are achievable. States such as New Hampshire have used creative financing measures to expedite the retrofit of state buildings for greater energy efficiency.[138] In January 2006, New Mexico Gov. Bill Richardson issued an executive order requiring new and renovated state buildings to meet "green building" standards including energy efficiency 50 percent better than the average for a given building type nationwide.[139] New Jersey has already boosted its purchases of renewable energy and there are ample opportunities to replace vehicles in the state fleet with more fuel efficient models.

Achieving these goals at both the state and the municipal government levels would lead to significant reductions in fossil fuel and electricity purchases. Given the recent increase in energy prices, which has played havoc with government budgets, measures that improve energy efficiency and invest in renewable energy aren't only good for the environment, but they also represent good fiscal stewardship for the taxpayers of New Jersey.

The Impact of the Strategies

The strategies listed above outline a path that would lead to significant reductions in carbon dioxide emissions in New Jersey. We estimate that the specific strategies listed above, coupled with commitments New Jersey has already made, would lead to a 21 percent reduction in carbon dioxide emissions below projected levels by 2020 and a 25 percent reduction by 2025. Compared with 2005 emission levels, carbon dioxide emissions in 2020 would 6 percent lower, while emissions in 2025 would be 7.4 percent lower. (See Fig. 11.)

Fig. 11. Projected Carbon Dioxide Emissions in New Jersey with Recommended Strategies



Saving Electricity Reduces Reliance on Nuclear Power

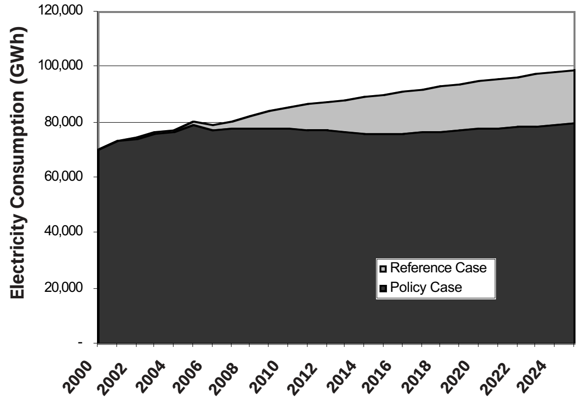
In addition to reducing emissions of global warming pollutants, the steps described in this report could also reduce New Jersey's dependence on nuclear power and shift the state's electricity generation mix toward renewable sources of energy.

Adopting the 11 steps discussed in this report, combined with the steps New Jersey has already taken, would reduce demand for electricity by nearly 20 percent by 2025, compared with projected levels. (See Fig. 12.)

Reduced electricity demand, combined with increased use of renewable energy, would allow New Jersey to make a dramatic shift in the mix of its electricity sources. Assuming that New Jersey continues to import roughly the same percentage of its power in future years as it does today, and assuming that efficiency gains and renewable energy sources are first used to replace power from nuclear power plants nearing the end of their operating lifetimes and then to offset generation from coal-fired power plants, the state will be able to dramatically scale back the portion of power it receives from dangerous nuclear power plants and pollution-intensive coal. (See Fig. 13.)

With regard to nuclear power, the savings resulting from energy efficiency improvements and expansion of renewable energy should allow New Jersey to reduce its dependence on nuclear power, thus allowing for the orderly and on-time retirement of Oyster Creek and Salem units I and II. (See Fig. 14.)

Fig. 12. Electricity Consumption in the Reference and Policy Cases



Note: Does not include savings from government-sector efficiency efforts.

Fig. 13. Projected Net Generation of Electricity by Power Source, New Jersey, 2025

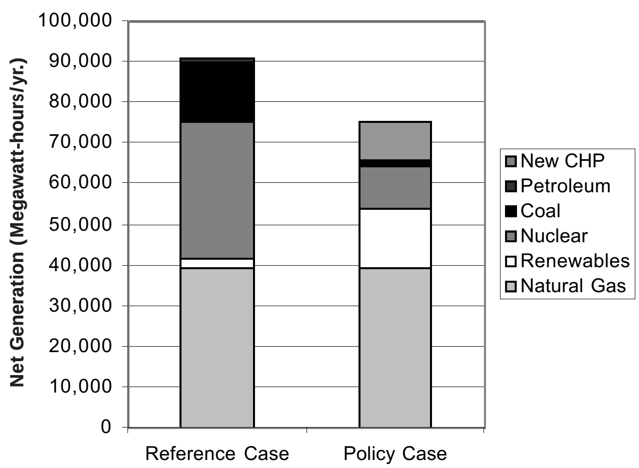
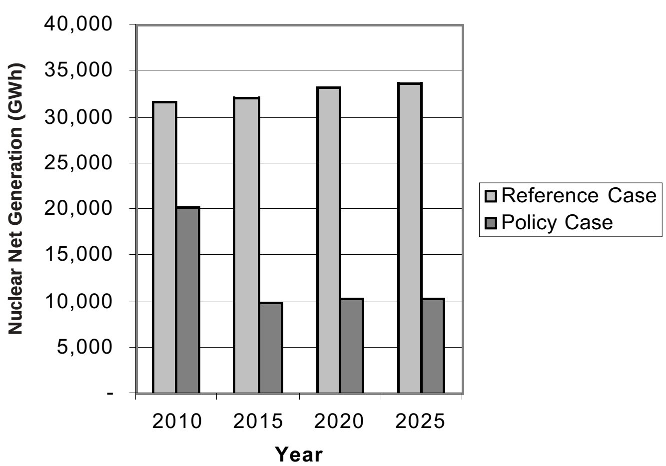


Fig. 14. Nuclear Power Net Generation, Reference and Policy Cases



Opportunities for Further Reductions

These strategies are not the only ones that have the potential to reduce global warming emissions in New Jersey. Indeed, the strategies listed above leave some major sources of global warming pollution—including air travel, industrial energy use, and emissions of non-carbon dioxide global warming pollutants—virtually untouched. New Jersey will need to develop effective strategies for stemming the growth of global warming emissions from these portions of the economy. The state also has the opportunity to reduce global warming pollution by substituting cleanly and sustainably produced renewable fuels (such as ethanol and biodiesel) for some portion of its petroleum use. Another option would be for New Jersey to pursue an economy-wide cap on all global warming emissions—enforced either at the state, regional or federal level.

An Economy-wide Cap on Global Warming Pollution

Each of the strategies listed above addresses global warming emissions from one sector of the state's economy. There are many benefits, however, to combining these specific clean energy policies with an overall, economy-wide cap on global warming pollution.

Adopting an economy-wide cap on emissions would:

1. Allow policy-makers to set enforceable targets for global warming emissions that are consistent with the latest climate science.
2. Prevent increases in global warming emissions from activities other than energy use (such as methane emissions from landfills) and from portions of the economy that are not covered by specific clean energy policies.
3. If structured as part of a cap-and-trade program, allow for global warming pollution reductions to come from the portions of the economy where they can be achieved at the lowest cost.

In 2006, the state of California adopted the nation's first statewide cap on global warming emissions, requiring emissions to be reduced to 1990 levels by 2020. Also in 2006, New Jersey Assemblywoman Linda Stender and New Jersey Senator Barbara Buono introduced legislation to adopt an economy-wide cap on New Jersey's global warming emissions. In addition to a statewide cap, such a policy can also be implemented at the regional or federal level. One option would be to expand RGGI to cover activities other than the generation of electricity. The European Union's emission trading scheme, for example, includes both electricity generators and other large industrial sources of global warming emissions. A second option would be for the federal government to step in with a strong, economy-wide program to limit global warming emissions.

Such a development would appear unlikely in the near term, given the Bush administration's resistance to mandatory measures to reduce global warming emissions. But there have been recent signals of change in Congress. In 2005, the U.S. Senate adopted a "Sense of the Senate" resolution concluding that global warming is occurring and that the nation should adopt a comprehensive national program to slow, stop and ultimately reverse growth in emissions of global warming pollutants.[140] And in 2006, Rep. Henry Waxman of California and Senator James Jeffords of Vermont both introduced legislation that would set strong targets for reduction of global warming emissions in the United States. New Jersey senators Frank Lautenberg and Robert Menendez and congressmen Frank Pallone, Steven Rothman, Robert Andrews and Donald Payne have co-sponsored this legislation.

New Jersey has an important role to play in the broader debate over efforts to reduce global warming emissions. First, as one of the states likely to be severely affected by global warming, New Jersey leaders have a responsibility to communicate the stakes of U.S. policy on global warming emissions to federal officials. Second, New Jersey can —and has already begun to—demonstrate policies that are both effective for reducing global warming emissions and also good for the economy. Finally, New Jersey should set its own, science-based targets for reducing global warming emissions and adopt the public policies necessary to ensure that they are met.

Putting it in Perspective – The Long-Term Goal

Ultimately, New Jersey's efforts to reduce global warming pollution will be judged by the speed with which the state can reduce—and eventually eliminate—its contribution to dangerous climate change. Achieving the long-term reductions in emissions of 70 to 85 percent that scientists believe will be needed to forestall dangerous climate change is the true test by which the state's efforts must be assessed, and should remain the overarching goal.

The strategies described in this report not only reduce New Jersey's global warming emissions in the short term, but they also begin to lay the groundwork for a deeper transition that will bring the long-term goals within reach. By implementing these strategies, New Jersey residents will drive vehicles that use less fuel and derive more of their energy from renewable sources, thus reducing New Jersey's global warming emissions and its dependence on petroleum. Our transportation system overall will become more efficient as New Jersey residents have a wider range of transportation options and as more travel and freight movement takes place through lower emission forms of transportation. Our homes, businesses and government offices will use energy more wisely—reducing the burden of high and volatile energy prices on our economy—and we will generate more of our power from clean, stable, renewable forms of energy. At the same time, New Jersey will deploy new and improved technologies—from advanced vehicles to highly efficient appliances to combined heat-and-power applications—that will situate the state for even greater reductions in emissions in the decades to come.

Even with these advances, New Jersey 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 buildings will have to be designed to minimize their reliance on fossil fuels. 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 New Jersey will have to do their share as well.

Making these changes will require an unprecedented amount of research, discussion, cooperation and political will. The early signs are positive: New Jersey has staked out a position of leadership on a host of policy issues related to reducing global warming emissions. And the state's government leaders, businesses, academics and citizens are engaged in the discussion and study of global warming, its impacts, and the means of addressing the problem in a deeper way that ever before.

The strategies laid out in this report show the way forward. By using existing technologies and reasonable public policy tools, New Jersey can make large strides towards 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 makes projections of New Jersey's future emissions of carbon dioxide and provides estimates of the emissions impacts of a variety of public policy strategies for addressing global warming.

There are several general assumptions and limitations that shape this analysis.

First, we rely primarily on energy consumption data and projections from the U.S. Energy Information Administration (EIA) to estimate past, present and future global warming emissions in New Jersey. Emissions through 2003 (with the exception of a few petroleum products, see "Baseline Emissions Estimates" below) are based on state-specific EIA estimates of energy consumption in New Jersey. Emissions for 2004 and future years are based on projected rates of growth in energy use for the Mid-Atlantic region (which includes New Jersey along with New York, Pennsylvania, Maryland and Delaware) adjusted to reflect the higher projected population growth in New Jersey versus the region as a whole. Specific conditions in New Jersey may be different than those in the region as a whole. Future projections of energy use depend on a range of assumptions as to the price and availability of various sources of energy and energy-consuming technologies. Thus, the projections should be viewed as one possible scenario for the future, though other scenarios are certainly possible.

Second, this analysis includes only emission of carbon dioxide from energy use and electricity production in New Jersey. Global warming is also exacerbated by emissions of other gases (such as methane and nitrous oxide) within New Jersey, by emissions of carbon dioxide resulting from the production of electricity in other states for use in New Jersey, and by "upstream" emissions resulting from the energy consumed to produce goods and services used by New Jersey residents. Thus, this analysis is not a comprehensive view of the cumulative impact of New Jersey on the global climate, but rather focuses only on the most significant means by which New Jersey affects the global climate (through energy-related emissions of carbon dioxide) and policy tools for reducing that impact.

All fees, charges and other monetary

values are 2005 dollars, unless otherwise noted.

Baseline Emissions Estimates

Baseline estimates of carbon dioxide emissions from energy use for 2003 and prior years were based on energy consumption data from EIA's State Energy Data database, downloaded from www.eia.doe.gov on 15 June 2006. For major petroleum products (gasoline, distillate fuel, residual fuel, kerosene and liquefied petroleum gases), 2003 and 2004 data were obtained from EIA's State Energy Data database on 28 August 2006. For other petroleum products, consumption in 2003 was estimated by applying the year-over-year percentage change in sales volume of the products to 2002 consumption data from the State Energy Data database. An exception to this methodology was made for the projection of future generation from wind power, since New Jersey had no wind power generation in 2003, but saw the opening of a small wind farm in 2005. We extrapolated future growth in wind power generation based on a 2006 baseline equivalent to the annual estimated production of electricity from the new wind farm, based on New Jersey Board of Public Utilities, *NJBPU Helps Unveil State's First Coastal Wind Farm* (press release), 12 December 2005.

To calculate carbon dioxide emissions, energy use for each fuel in each sector (in BTU) was multiplied by carbon coefficients as specified in EIA, *Documentation for Emissions of Greenhouse Gases in the United States 2003*, May 2005.

Adjustments were made for storage of carbon through non-fuel industrial consumption of natural gas and petroleum products using data and following the methodologies described in EIA, *Documentation for Emissions of Greenhouse Gases in the United States 2003* ("*Documentation*"), May 2005. To calculate the percentage of various petroleum products used for non-fuel purposes, we either used EIA's assumptions as described in the document above, or compared the quantity of fuels used for non-fuel purposes in *Documentation* with total U.S. consumption of the products from the State Energy Data database. We derived the percentage of carbon dioxide that is released from non-fuel uses of petroleum and natural gas from values presented in *Documentation*.

Combustion of wood, biomass and waste was excluded from the analysis per EIA, *Documentation*. 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." Municipal solid waste is considered a "biofuel" by EIA and its emissions are excluded.

Future Year Projections

Projections of energy use and carbon dioxide emissions for New Jersey are generally based on applying the Mid-Atlantic Region year-to-year projected growth rate for each fuel in each sector from EIA's *Annual Energy Outlook 2006* (*AEO 2006*) to the New Jersey baseline emissions estimate for 2003. Because New Jersey's population (and presumably its economic activity) is projected to increase at a faster rate than the Mid-Atlantic region as a whole, we multiplied the year-by-year growth rate from *AEO 2006* by the ratio between the projected population growth rate in New Jersey (from the U.S. Census Bureau), and the regional population growth rate assumed in *AEO 2006*.

We further assumed that the major public policy steps described in the "Commitments Already Made" section are not factored into the estimates of energy use in *AEO 2006*. EIA states that *AEO 2006* reflects all legislation and policies adopted as of October 31, 2005. However, *AEO 2006* explicitly does not include energy savings from vehicle tailpipe standards for global warming pollutants and would not include savings from New Jersey's 20 percent renewable energy standard, which was adopted in early 2006, or from the RGGI program, which has still not been formally adopted in the states.

Carbon Dioxide Reductions From Electricity Savings and Renewable Energy Use

Measures that reduce electricity consumption in New Jersey or that expand renewable electricity generation were assumed to reduce the generation of electricity in New Jersey by a proportional amount. That is to say, the proportion of electricity New Jersey is projected to import from other states to serve local demand was held constant in this analysis. To account for this, reductions in net generation from these strategies were multiplied by 0.72 to reflect the ratio of electricity generation in New Jersey to electricity sales in the state in 2004, per EIA, *State Electricity Profiles 2004*.

Carbon dioxide emission reductions resulting from reduced demand for fossil and nuclear-powered generation in New Jersey were calculated as follows:

Net electricity generation from each type of fuel was estimated by multiplying consumption of each fuel for electricity generation in New Jersey (from the EIA State Energy Data database) by the average heat rate of generators using that fuel for the Mid-Atlantic Area Council (MAAC) electric reliability region (of which New Jersey is a part). Heat rates for fossil fuel-fired power plants were calculated by dividing the amount of each fuel consumed in the MAAC region by the net generation from that fuel (with both figures coming from the supplementary tables to EIA's *AEO 2006*). For nuclear and renewable electricity generation, the heat rate was assumed to be the average for fossil fuel power plants in the United States, per EIA, *State Energy Consumption, Price and Expenditure Estimates (SEDS), Technical Notes for Updated Data*, Appendix B, downloaded from www.eia.doe.gov/emeu/states/_seds_updates_tech_notes.html, 19 July 2006.

Reductions in net fossil and nuclear power generation from energy efficiency improvements and renewable energy (calculated as described below) were assumed to reduce the need for electricity generation versus the reference case projection in the following manner:

Net generation from nuclear power was offset first, until 69 percent of projected nuclear power generation was offset. The 69 percent figure represents the percentage of nuclear net generation provided by Hope Creek (from a comparison of Hope Creek's generating capacity in 2004 versus total New Jersey nuclear generation capacity from EIA, *State Electricity Profiles 2004*, June 2006).

Additional reductions were assumed to offset generation first from coal and then from natural gas-fired generation.

The resulting estimates of net generation by fuel after the policy measures were then multiplied by the heat rate (derived as described above) to estimate the amount of fuel consumed for electricity generation. Fuel consumption was then multiplied by the appropriate carbon coefficient to estimate carbon dioxide emissions.

The carbon dioxide emissions from electricity generation remaining in 2025 after application of this method were somewhat higher than New Jersey's target for electric sector emissions under the Regional Greenhouse Gas Initiative. As a result, the RGGI target determines carbon dioxide emissions for the electric sector in the combined policy case presented in the conclusion of this document. This method does produce the estimates of the state's electricity mix included in the conclusion of the report.

Emission Reductions From the Strategies

Commitments Already Made

Clean Cars Program

The percentage reduction in carbon dioxide emissions that can be expected from implementation of the Clean Cars program was based on estimated percentage reductions in per-mile global warming emissions due to the standards per California Environmental Protection Agency, Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles*, 6 August 2004.

To calculate the reductions New Jersey could expect from the standards, we sought to answer the following questions:

1) What percentage of the vehicle-miles traveled each year would be from vehicles of the various model years/ages? This would determine the emission standard to which the vehicles are held and how much carbon dioxide the vehicles would emit per mile.

2) What percentage of vehicle-miles will be traveled in cars versus SUVs? The Clean Cars Program includes different standards for cars and light trucks.

3) What would carbon dioxide emissions have been were the Clean Cars Program not in place? And what would emissions be under the standards?

1. Estimating Vehicle-Miles Traveled by Age

To estimate the amount of miles that would be traveled by vehicles of various ages, we relied on data on VMT accumulation by vehicle age from the U.S. Department of Transportation's 2001 National Household Transportation Survey (NHTS, downloaded from nhts.ornl.gov/2001/index.shtml, 21 June 2006). We used the estimates of the number of miles driven per vehicle by vehicles of various ages from NHTS to estimate the percentage of total VMT in any given year that could be allocated to vehicles of various model years. (To eliminate year-to-year anomalies in the NHTS data, we smoothed the VMT accumulation curves for cars and light trucks using several sixth-degree polynomial curve fits.)

2. Estimating the Percentage of Vehicle-Miles Traveled by Cars and Light Trucks

To estimate the percentage of vehicle-miles traveled accounted for by cars and light-duty trucks, we relied on two sources of data: actual VMT splits by vehicle type for 2000 through 2002 from the Federal Highway Administration, *Highway Statistics* series of reports and projections of future VMT splits output from the EPA's MOBILE6 mobile source emission estimating model. (New Jersey-specific data on VMT splits are unavailable but the state has a higher ratio of registered cars to trucks than the national average, according to Federal Highway Administration, *Highway Statistics 2002*, October 2003, Table MV-1. This should make our analysis of the programs' benefits slightly lower than will likely occur because per-mile emission reductions for cars are greater than for trucks and total emission reductions are undercounted in New Jersey by using national figures for car and light truck registrations.)

EPA's projections of the VMT split among cars and light-duty trucks assign significantly more VMT to light-duty trucks than has been the case over the past several years, according to FHWA data. However, EPA's long-term projection that light trucks will eventually represent 60 percent of light-duty vehicle sales by 2008 appears to be reasonable in light of the continued trend toward sales of light trucks.

In order to estimate a trend that reflects both the more car-heavy current makeup of VMT and the long-term trend toward increasing travel in light trucks, we created two curves, one extrapolating the continued linear decline in the car portion of light-duty VMT based on trends in FHWA data from 1990 to 2002 and another using the EPA MOBILE6 estimates. We then assumed that the split in VMT would trend toward the EPA estimate over time, so that by 2020, cars are responsible for approximately 50 percent of light-duty VMT.

VMT in the light-truck category were further disaggregated into VMT by "light" light trucks (in the California LDT1 category) and heavier light trucks (California LDT2s), per EPA, *Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6*, September 2001.

3. Estimating Carbon Dioxide Emissions With and Without the Standards

Baseline carbon dioxide emissions without the Clean Cars Program are based on assumptions about future vehicle fuel economy from EIA, *AEO 2006*. These fuel economy estimates were translated into per-mile carbon dioxide emission factors assuming that consumption of a gallon of gasoline produces 8,869 grams (19.6 pounds) of carbon dioxide. This figure is based on carbon coefficients and heat content data from U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2001*, Appendix B. Fuel economy estimates for years prior to 2003 were based on EPA laboratory fuel economy values from EPA, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004, April 2004*. Both the EIA estimates of future fuel economy and the EPA estimates of historic fuel economy were multiplied by an "on-road degradation factor" (representing the degree by which real-world fuel economy falls below EPA laboratory results) from *AEO 2006*.

Emissions from vehicles complying with the standards were estimated by multiplying the percentage reduction in emissions attributed to the standards (obtained from CARB as described above) for each model year to the 2002 emissions level for that class of vehicles. For all years until 2016, vehicles sold by intermediate and small vehicle manufacturers were assumed not to comply with the standards (due to an exemption in the California law) and were assigned emissions at the same rate as calculated for the reference case scenario (described above). Intermediate and small manufacturers were assumed to sell 12.7 percent of cars and 6 percent of light trucks, based on national estimates from Ward's Communications, *2003 Ward's Automotive Yearbook*, 233. In 2016 and subsequent years, small and intermediate manufacturers were assumed to achieve carbon dioxide emission reductions of 25 percent for cars and 18 percent for light trucks per a compliance option for those manufacturers described in Title 13 CCR 1961.1(C).

Fleet Emission Projections

Based on the above data, scenarios were created comparing the reference case (essentially, what emissions from the fleet would have been without the Clean Cars Program) and a policy case. Emission factors for each vehicle class and model year were calculated as described above, and multiplied by the share of total VMT attributed to vehicles of that vehicle class and model year. Total emissions were then summed across vehicle classes and model years to arrive at an estimate of total emissions from the light-duty fleet in any given year. The emissions estimate for the policy case was then compared to the emissions estimate from the reference case to arrive at an estimate of the percentage by which the Clean Cars Program would reduce light-duty vehicle emissions in any particular year. This estimate was then multiplied by the estimated amount of emissions from light-duty vehicle gasoline consumption in our reference case to arrive at the total reduction that would result from implementation of the Clean Cars Program.

In addition to the above, we made the following assumptions:

- **Rebound effects** – Research has shown that improved vehicle fuel efficiency often results in an increase in vehicle-miles traveled. By reducing the marginal cost of driving, efforts to improve efficiency provide an economic incentive for additional vehicle travel. Studies have found that this "rebound effect" may reduce the carbon dioxide emission savings of fuel economy-improving policies by as much as 20 to 30 percent.[141] To account for this effect, carbon dioxide reductions in each of the scenarios were discounted by 10 percent. This estimate is likely quite conservative: in its own analysis using California-specific income and transportation data, CARB estimated a rebound effect ranging from 7 percent to less than 1 percent.[142]
- **Mix shifting** – We assumed that neither of the policies under study would result in changes in the class of vehicles purchased by New Jersey residents, or the relative amount that they are driven (rebound effect excluded). In addition, we assumed that the vehicle age distributions assumed by EPA remain constant under each of the policies. In other words, we assumed that any increase in vehicle prices brought about by the global warming emission standards would not dissuade consumers from purchasing new vehicles or encourage them to purchase light trucks when they would otherwise purchase cars (or vice versa). Mix shifting impacts such as these are quite complex and modeling them was beyond the scope of this report, but they do have the potential to make a significant impact on future carbon dioxide emissions.

Regional Greenhouse Gas Initiative (RGGI)

To estimate the impact of RGGI, we assumed that carbon dioxide emissions from New Jersey's electricity sector would be equivalent to the allowance allocation for New Jersey as described in the Regional Greenhouse Gas Initiative, *Regional Greenhouse Gas Initiative Memorandum of Understanding*, 20 December 2005.

This method is likely to overestimate the emission reductions from RGGI for two reasons: 1) it does not account for emissions from a number of small electric generators that do not meet the size threshold for inclusion in RGGI (25 MW); 2) it does not account for a variety of flexibility mechanisms (such as offsets) and safety valves that could allow electric generators to emit more carbon dioxide than called for under the RGGI cap. Because the RGGI model rule has not been adopted by the states, the extent of the flexibility mechanisms available to generators and the scope of the program remain undetermined, the exact emission reductions that will be delivered by RGGI are difficult to predict.

Clean Energy Standard

Emission reductions from New Jersey's 20 percent clean energy standard were estimated by multiplying the percentage of renewable power required in each year (per NJAC 14:8-2.1 et seq.) to New Jersey's projected net generation of electric power (derived using the methodology described in "Estimating Emission Reductions from Energy Efficiency and Renewable Energy" above), and then dividing by 0.9, which represents the estimated 10 percent of renewable power that would be lost in transmission. We then multiplied the renewable energy target by the percentage of the state's total power consumption currently generated within the state, or 72 percent, to estimate the percentage of renewable power generation that would be built within New Jersey. From this figure, we then subtracted the amount of renewable electricity generation projected for New Jersey in the reference case to arrive at an estimate of new renewable generation in New Jersey resulting from the renewable energy standard. This renewable generation was assumed to offset nuclear and fossil fuel-fired generation as described in "Estimating Emission Reductions from Energy Efficiency and Renewable Energy," above.

Existing Energy Efficiency Programs

The amount of energy saved by New Jersey's existing energy efficiency programs is based on reported annual savings from the New Jersey Clean Energy Program in its annual reports from year 2001 through 2005. Annual electricity and natural gas savings for years 2006 through 2008 are based on projected increases in energy efficiency spending from New Jersey Board of Public Utilities, *In the Matter of Comprehensive Energy Efficiency and Renewable Energy Resource Analysis for 2005-2008: Funding Allocation and Program Budget*, Docket No. EX04040276, 23 December 2004. Annual savings were based on multiplying the 2005 annual kilowatt-hour (electricity) and therm (natural gas) savings from New Jersey Board of Public Utilities, Office of Clean Energy, *New Jersey's Clean Energy Program 2005 Annual Report*, undated, by the percentage increase in efficiency program spending for 2006 through 2008 from the December 2004 BPU order described above. Annual energy efficiency savings for 2009 and subsequent years were assumed to be the same as 2008. Cumulative savings from previous energy efficiency measures in any particular year were based on the ratio between lifetime savings and annual savings from electric and natural gas efficiency measures in New Jersey Board of Public Utilities, Office of Clean Energy, *New Jersey's Clean Energy Program 2005 Annual Report*, undated, which was approximately 9-to-1 for electricity savings and 18-to-1 for natural gas savings. Total electricity savings for any particular year were estimated to be the annual savings for measures implemented in that year plus the annual savings for measures implemented in the previous eight years for electricity and the previous 17 years for natural gas. This is a simplistic assumption; in reality, the degree to which energy efficiency investments made in any particular year deliver energy savings in a future year depend on the type of measures undertaken (for example, installing an energy-efficient light bulb may deliver energy savings for a couple of years while installing an energy-efficient furnace may deliver savings for decades). We anticipate that this simple method of estimating future-year energy efficiency savings will tend to inflate savings in the first years after the energy efficiency improvements are made and understate savings in later years.

For electricity savings, reductions in site energy use were divided by 0.9 (to account for transmission losses) to estimate the amount of net generation that would be displaced. Carbon dioxide emission reductions were estimated according to the method described in "Estimating Emission Reductions from Energy Efficiency and Renewable Energy," above.

Additional Strategies

Energy-Saving Tires

Savings from the use of low-rolling resistance replacement tires were estimated using a methodology developed for RIPIRG Education Fund, *Cars and Global Warming*, Winter 2005. Emission reductions were generated by reducing carbon dioxide emission factors by 3 percent from baseline assumptions for vehicles reaching four, seven and 11 years of age, beginning in 2009, per California Energy Commission, *California Fuel-Efficient Tire Report*, Volume II, January 2003. Vehicle age estimates were based on VMT accumulation rates presented in U.S. Environmental Protection Agency, *Fleet Characterization Data for MOBILE6*, September 2001. This estimate assumes that the tire stock will completely turn over, that is, that LRR tires will supplant non-LRR replacement tires in the marketplace through a state requirement. Other policies to encourage, but not mandate, LRR tires would likely produce reduced savings.

Pay-As-You-Drive Automobile Insurance

The impact of pay-as-you-drive automobile insurance on vehicle travel was estimated by modifying a formula to estimate the response of driving demand to changes in per-mile marginal prices presented in Aaron S. Edlin, *Per-Mile Premiums for Auto Insurance*, University of California, Berkeley, 2002. The formula is as follows:

$$M=M_O-(e * (p/t_O))$$

Where:

M represents travel demand after institution of per-mile premiums

M_0 represents travel demand before institution of per-mile premiums

e represents the elasticity of vehicle travel with respect to marginal price per mile

p represents the per-mile cost of insurance

t_0 represents the marginal, per-mile cost of driving before the institution of per mile insurance

The value M_0 is set to 1, so that the value M provides the relative change in vehicle travel after the imposition of per-mile insurance. Elasticity of vehicle travel with respect to marginal price per mile (e) is based on recent estimates of the elasticity of vehicle travel with respect to gasoline prices produced by economist Charles Komanoff and available at www.komanoff.net/oil_9_11/price_elasticity_komanoff.xls. The version used in this analysis was produced on 30 May 2006. Per-mile cost of insurance (p) is based on 80 percent of the average collision and liability insurance expenditure in New Jersey in 2003 from Insurance Information Institute, *Facts and Statistics: Average Expenditures for Auto Insurance by State, 1999-2003*, downloaded from www.iii.org/media/facts/statsbyissue/auto, 21 June 2006. The value t_0 includes per-mile expenditures for gasoline, maintenance and tires from American Automobile Association, *Your Driving Costs 2006*, downloaded from www.aaapublicaffairs.com/Assets/Files/2006328123200.YourDrivingCosts2006.pdf, 25 July 2006. It also includes an estimate of per-mile depreciation costs of 15 cents per mile, based on the upper bound of an estimate in Victoria Transport Policy Institute, *TDM Encyclopedia: The Cost of Driving and Savings from Reduced Vehicle Use*, updated 14 December 2005.

The reduction in driving demand resulting from this calculation was applied to reference case projections of light-duty vehicle gasoline consumption to arrive at the reduction in energy use and carbon dioxide emissions that would result. Per-mile insurance was assumed to be phased in for 25 percent of drivers in 2008, with an additional 25 percent of drivers added in the following three years until all drivers are covered by per-mile insurance in 2011.

Reduce the Number of Automobile Commutes

The impact of a mandatory commute-trip reduction program in New Jersey is based on the following assumptions:

1) The program would include all New Jersey employers with more than 100 employees (regardless of whether those employees work at a single worksite or multiple worksites).

2) The program will include a goal of reducing commuting miles traveled by 15 percent in 2008, with the goal increasing by 5 percent over the next two years and by 10 percent in the following year until a 40 percent reduction in commuting miles traveled is achieved in 2012.

3) Compliance with the program is 75 percent.

Commutes were estimated to account for approximately 27 percent of vehicle travel in New Jersey based on national estimates from U.S. Department of Transportation, Federal Highway Administration, *Summary of Travel Trends: National Household Transportation Survey 2001*, December 2004. Workers at firms with more than 100 employees were assumed to represent 63 percent of all New Jersey workers based on U.S. Census Bureau, *Statistics of U.S. Businesses: 2001: New Jersey – All Industries by Employment Size of Enterprise*, downloaded from www.census.gov/epcd/susb/2001/nj/NJ—.htm, 19 June 2006.

Reduce Growth in Vehicle Travel

Estimated carbon dioxide reductions from reduced growth in vehicle travel are based on the assumption that per-capita vehicle travel in New Jersey is stabilized beginning in 2008. Future VMT growth increases are held to the rate of population growth projected for New Jersey in U.S. Census Bureau, *Interim State Population Projections 2005*, 21 April 2005, Table 7. An annual rate of population growth was calculated from the Census Bureau's projections of population growth by decade. This rate of growth was compared to the rate of VMT growth implied by EIA's projections of increases in transportation gasoline consumption and fuel economy from *AEO 2006*. The ratio of these two VMT growth rates was then applied to the year-over-year growth rate in transportation gasoline consumption from *AEO 2006* and this was compared to the gasoline consumption projection in the reference case to determine the percentage by which gasoline consumption would be reduced through slower growth in vehicle travel.

We assumed that the reduction in vehicle travel growth in this scenario would take place as a result of changes in land-use patterns and availability of transportation alternatives. As a result, the carbon dioxide reductions from this scenario are in addition to, and not a substitute for, VMT reductions obtained through other strategies, such as commute-trip reduction programs and per-mile insurance premiums.

Freight Rail Infrastructure

Savings from improvements to New Jersey's freight rail infrastructure were estimated based on the assumption that freight rail improvements could eventually displace 25 percent of heavy-duty freight truck travel on New Jersey highways, per a regional estimate included in I-95 Corridor Coalition, *Mid-Atlantic Rail Operations Study*, April 2002. This reduction was applied to the estimated diesel consumption of heavy-duty trucks in New Jersey, which was derived by multiplying total transportation sector diesel consumption from the reference case by the share of transportation diesel fuel consumed by heavy-duty trucks nationally, per the supplementary tables to *AEO 2006*. The 25 percent reduction was applied beginning with a 2.5 percent reduction in 2015, with additional 2.5 percent reductions annually until 2025. The amount of additional carbon dioxide emissions that would result from the increase in freight rail travel was estimated by multiplying the emissions saved through diversion of freight truck traffic by the ratio between energy consumption by freight trains per ton-mile and energy consumption by freight trucks per ton-mile, both from U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Transportation Energy Intensity Indicators*, downloaded from intensityindicators.pnl.gov/trend_data.stm, 7 July 2006.

40 Miles per Gallon Fuel Economy Standard

The assumptions and methodology for calculating the impact of a 40 MPG fuel economy standard are similar to those used in calculating the impact of the Clean Cars Program, as described above. We assume that the 40 miles per gallon standard applies to both cars and light trucks and is phased in linearly beginning in 2009 and ending in 2018. For the sake of simplicity, we assume an on-road fuel economy degradation factor of 0.8 for both cars and light trucks in this scenario.

Combined Transportation Strategies

Combined emission reductions estimated from the transportation strategies were derived by multiplying the percentage of emissions remaining from each of the strategies by the percentage remaining from the other strategies. The combined policy case includes the emission reductions from the 40 miles per gallon fuel economy standard and not emission reductions from the Clean Cars Program, since the two programs overlap.

Residential, Commercial and Industrial Strategies

Residential and Commercial Building Codes

The projected impact of building energy codes is based on the assumption that building code improvements will only affect the energy efficiency of new buildings. Since building codes affect both new buildings and major renovations of existing buildings, the emission reductions projected here are likely conservative.

For residential codes, the proportion of projected residential energy use from new homes was derived by subtracting estimated energy use from homes in existence prior to 2008 from total residential energy use for each year based on *AEO 2006* growth rates. Consumption of energy by surviving pre-code homes was calculated by assuming that energy consumed per home remains stable over the study period and that 0.3 percent of homes are retired each year, per EIA, *Assumptions to AEO 2006*.

For commercial building codes, commercial building retirement percentages were estimated for states in the U.S. Census Mid-Atlantic Region by determining the approximate median age of commercial floorspace in the Mid-Atlantic Region based on data from EIA, *2003 Commercial Building Energy Consumption Survey* (CBECS); estimating a weighted-average “gamma” factor (which approximates the degree to which buildings are likely to retire at the median age); and inputting the result into the equation, Surviving Proportion = 1/(1+(Building Age/Median Lifetime)^{Gamma} as described in EIA, *Assumptions to Annual Energy Outlook 2006*. Baseline 2007 commercial energy demand was then multiplied by the percentage of surviving per-code commercial buildings to estimate the energy use from buildings not covered by the code.

Energy savings from code improvements were based on the following assumptions:

For residential codes, a 16.5 percent reduction in oil and natural gas consumption in new homes, beginning in 2008, based on an estimated 15 percent reduction that would result from replacing New Jersey’s current building code with the IECC 2000 code (from Steven Nadel and Howard Geller, American Council for an Energy-Efficient Economy, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions Through Greater Energy Efficiency*, September 2001) and an additional reduction beyond IECC 2000 from adopting the IECC 2004 code (based on comparing estimated energy savings from the IECC 2004 code from William Prindle, Bion D. Howard, *Impact Assessment of 2004 IECC Wall Criteria Changes*, American Council for an Energy-Efficient Economy, September 2005 with estimated household space heating energy consumption from EIA, *2001 Residential Energy Consumption Survey: Household Energy Consumption and Expenditures Tables*, Table CE2-9c). Beginning in 2011, we assume further reductions in energy consumption of 20 percent, assuming that new codes will be implemented that are comparable with the revised Energy Star homes standard implemented in 2006 and described in U.S. Environmental Protection Agency, U.S. Department of Energy, *Guidelines for Energy Star Qualified New Homes*, downloaded from www.energystar.gov/index.cfm?c=bldrs_lenders_raters.homes_guidelns09, 20 July 2006. With regard to electricity consumption, we assume a 15 percent reduction from adopting the IECC 2000 code and a further 20 percent reduction in 2011 from adopting a code similar to the current Energy Star homes standard.

For commercial codes, we assume a 10 percent reduction in consumption of all fuels in new commercial buildings, beginning in 2008 from adoption of the ASHRAE 90.1-2004 code based on a personal communication between Elizabeth Ridlington of Frontier Group and Cathy Higgins of New Buildings Institute, 10 August 2005. We further assume the adoption of more stringent codes that will reduce energy use in new commercial buildings by 25 percent beginning in 2011.

Appliance Efficiency Standards

Estimates of potential energy savings from appliance efficiency standards were based on state-specific estimates for New Jersey from American Council for an Energy-Efficient Economy (ACEEE) and Appliance Standard Awareness Project (ASAP), *Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards*, March 2006. Electricity and natural gas savings estimates were prorated between the anticipated date on which the standards would be imposed and 2020, and then between 2020 and 2030. Standards related to heating and lighting energy use were assumed to be covered under building codes for new buildings, and 30 percent of the savings from those measures were eliminated in order to avoid double-counting in the combined policy case.

Expanded State Energy Efficiency Programs

Emission reductions from the doubling of funding for state energy efficiency programs were calculated in a similar manner to reductions from existing energy efficiency programs as described above. Estimates of future annual electricity and natural gas savings were assumed to be double the level projected for existing programs (as described above), minus 25 percent to account for the elimination of "low-hanging fruit" efficiency savings that would be achieved through existing funding.

Expanded Use of Combined Heat and Power

Future commercial and industrial power generation from CHP were estimated based on deployment of CHP under the "advanced case" presented in Kema, Inc., *New Jersey Energy Efficiency and Distributed Generation Market Assessment*, August 2004. We assumed that the 2104 MW of CHP described in the Kema study would be phased in linearly between 2007 and 2020, with no further increases after 2020. The amount of net electricity generation that would be displaced by CHP was calculated assuming a 63 percent capacity utilization factor imputed from current U.S. CHP generation and generation capacity as presented in American Council for an Energy-Efficient Economy, *Combined Heat and Power: The Efficient Path for New Power Generation*, downloaded from www.aceee.org/energy/chp.pdf, 20 July 2006. We further assumed that generation from CHP would offset an additional 10 percent of generation from centrally produced power to account for transmission losses from centrally produced power.

Additional global warming emissions from natural gas consumed in CHP applications were estimated based on a heat rate of 5,000 BTU/kWh from Western Resource Advocates, *A Balanced Energy Plan for the Interior West*, 2004.

Government "Lead By Example"

Baseline estimates of public sector energy consumption in New Jersey came from the following sources:

- Government buildings – Government building energy use was estimated by dividing estimated energy consumption in government buildings by estimated energy use in all commercial buildings based on data from EIA, *2003 Commercial Buildings Energy Consumption Survey* (CBECS). For electricity and natural gas, Mid-Atlantic regional figures were used. For heating oil, Northeast regional estimates were used. The resulting percentage was then applied to New Jersey commercial energy consumption in the reference case to arrive at an estimate of government building energy use in New Jersey. Fuels not included in CBECS were assumed not to be used in New Jersey government buildings.
- Government vehicles – Government vehicle energy use was estimated by dividing public sector gasoline consumption with total gasoline consumption in New Jersey from U.S. Department of Energy, Federal Highway Administration, *Highway Statistics 2004*, October 2005. Government vehicle diesel use was assumed to represent the same percentage of diesel use as government vehicle gasoline use.

To these baseline estimates of government energy use, we then applied the following strategies:

- 25 percent reduction in government energy use, beginning in 2007 and phased in over 10 years;
- 50 percent reduction in new building energy consumption, assuming that all additional government building energy consumption beyond 2006 takes place in new buildings;
- 40 percent of electricity from renewable energy, assuming that renewable energy displaces nuclear and fossil fuel generation as described above;
- Replacing government vehicles with the most efficient vehicles available. We assume that the most efficient vehicles are 30 percent more efficient than current vehicles based on the average difference between the average fuel economy of vehicles in each vehicle class and the most-efficient vehicle in that class from U.S. Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2005*, July 2005.

Combined Policy Case

The combined policy case includes emission reductions from all the strategies described above, with the following exceptions:

- The policy case does not include emission reductions from some appliances subject to both appliance efficiency standards and updated building codes.
- The policy case does not include emission reductions from the Clean Cars Program, since it overlaps with benefits from the 40 miles per gallon fuel economy standard for light-duty vehicles.

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