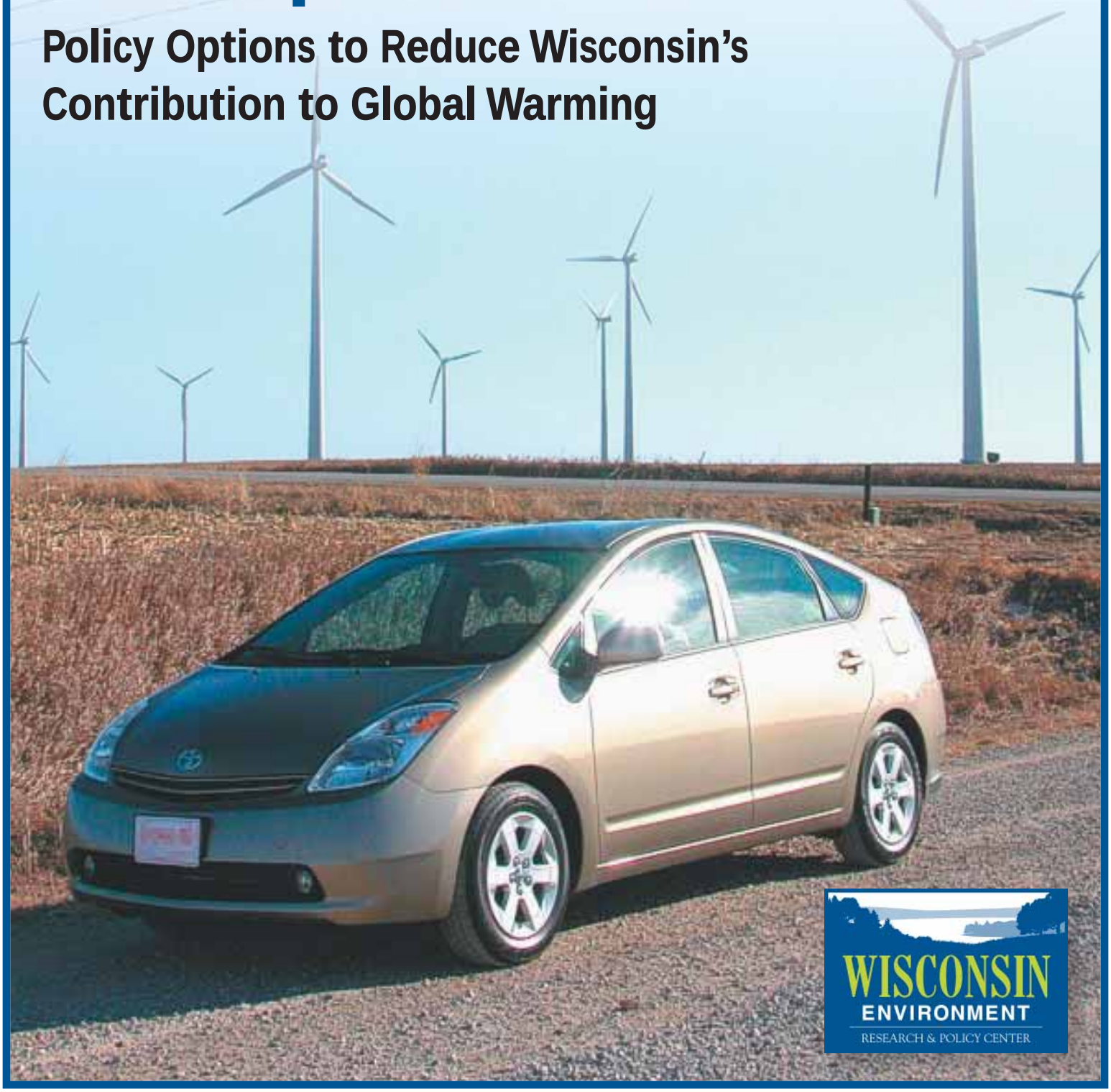


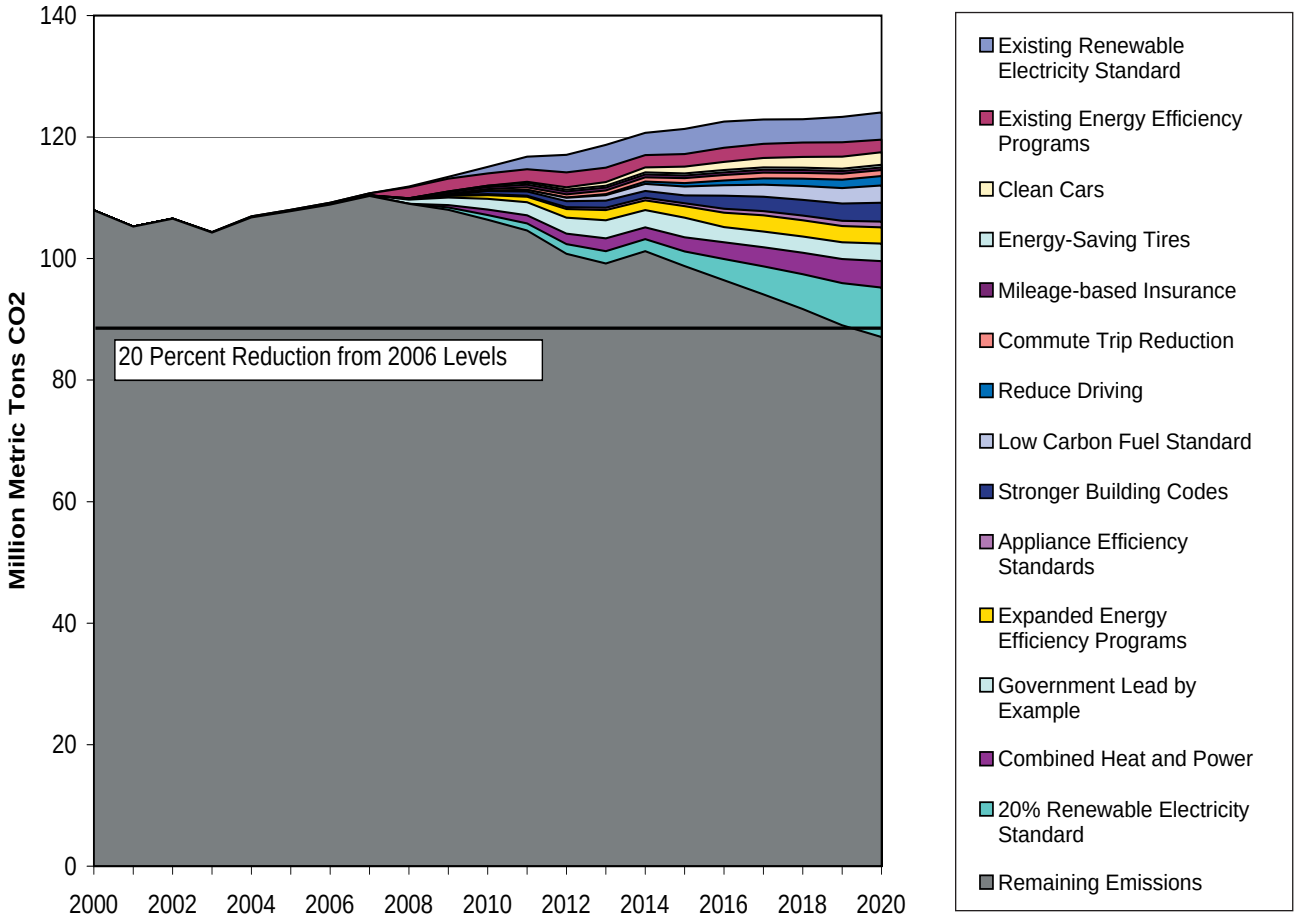

# A Blueprint for Action

## Policy Options to Reduce Wisconsin's Contribution to Global Warming



WISCONSIN ENVIRONMENT
RESEARCH & POLICY CENTER

**Carbon Dioxide Emissions in Wisconsin with Recommended Policies**



# A Blueprint for Action

## Policy Options to Reduce Wisconsin's Contribution to Global Warming


Joshua Hoen
Frontier Group
Elizabeth Ridlington
Frontier Group
Dan Kohler
Wisconsin Environment Research
and Policy Center

December 2007

# Acknowledgments

Wisconsin Environment Research & Policy Center thanks the following individuals for their review of this report: Jennifer Giegerich of Wisconsin League of Conservation Voters, Steve Hinker of 1000 Friends of Wisconsin, and Keith Reopelle of Clean Wisconsin. Thanks also to Tony Dutzik of Frontier Group for technical and editorial assistance.

This report is made possible with funding from the Beldon Fund.

The opinions expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided editorial review. Any factual errors are strictly the responsibility of the authors.



Wisconsin Environment Research & Policy Center is a 501(c)(3) organization. We are dedicated to protecting Wisconsin's air, water and open spaces. We investigate problems, craft solutions, educate the public and decision makers, and help Wisconsinites make their voices heard in local, state and national debates over the quality of our environment and our lives.

Frontier Group conducts independent research and policy analysis to support a cleaner, healthier and more democratic society. Our mission is to inject accurate information and compelling ideas into public policy debates at the local, state and federal levels.

For additional copies of this report, please visit www.wisconsinenvironment.org, or send $20 to:

Wisconsin Environment Research & Policy Center
122 State St., Ste. 310
Madison, WI 53703

Cover photo: Solar panels, NREL; biofuel pump, Charles Bensinger; insulation, VEIC
Design: Kathy Fors, Kathleen Krushas – To the Point Publications

# Table of Contents

# Executive Summary

Global warming poses a serious threat to Wisconsin's future well-being and prosperity. To do its part to avoid the worst impacts of global warming, Wisconsin needs to reduce its global warming pollution 20 percent by 2020 and 80 percent by 2050, setting an example for the rest of the nation to follow.

Thankfully, many technologies and policy tools exist that could substantially reduce Wisconsin's contribution to global warming, while moving the state toward a clean, secure energy future. Wisconsin has already taken several significant steps to cut its global warming pollution, but vast opportunities to further reduce emissions remain untapped.

This report details 13 policy strategies, in addition to several steps already taken, that would cut Wisconsin's emissions of carbon dioxide—the leading greenhouse gas—by 30 percent below projected levels by 2020. Adoption of these strategies will put Wisconsin on course to reducing its contribution to global warming in line with what scientists believe will be necessary to prevent catastrophic climate change.

**Global warming is happening now and poses a serious threat to Wisconsin's future.**

- Global average temperatures increased by more than 1.4° F in the past century. Sea level is rising, ice and snow cover are decreasing, and storm intensity has increased.
- Human activity—particularly the burning of fossil fuels—is the primary cause of global warming. Fossil fuel consumption releases carbon dioxide, which traps radiation from the sun near 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.
- World average temperatures could increase by another 3 to 7° F above late 20th century levels by the end of this century, depending on future emissions of global warming pollutants. Sea level could rise by between 11 and 17 inches, threatening low-

lying coastal areas. And the ecological balance upon which life depends could be irrevocably altered.

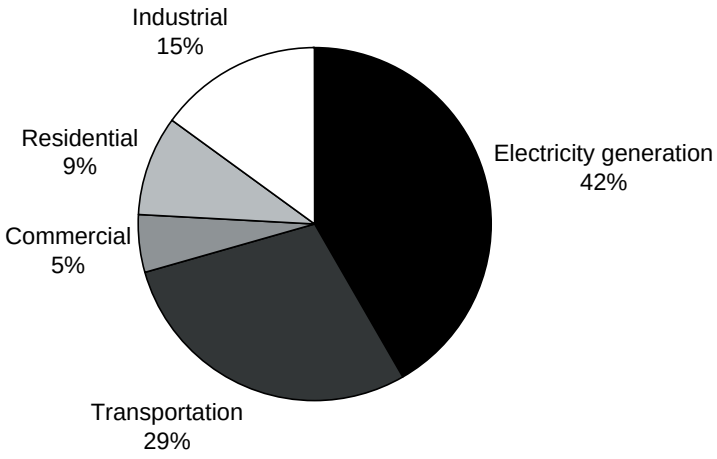
**Immediate action is needed to prevent the worst impacts of global warming.** Scientists tell us that if we act quickly and aggressively to reduce global warming emissions there is a much greater chance of staving off the worst impacts of global warming. To keep global temperatures from rising by more than 2.0° C (3.6° F), 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 United States is the world's largest global warming polluter, the degree of emission reductions required here will be greater than in less-developed countries.

By making a commitment to reducing global warming pollution and setting in motion the changes that will meet that target, Wisconsin can reduce its own significant contribution to global warming while encouraging others to do the same.

**Emissions of global warming pollution are on the rise in Wisconsin.**

- Between 1990 and 2004, Wisconsin's emissions of carbon dioxide from energy use increased by 26 percent. Electricity generation and transportation are the biggest sources of carbon dioxide pollution in the state (42 percent and 29 percent, respectively), followed by the direct use of fossil fuels in industry (15 percent), homes (9 percent) and businesses (5 percent). (See Figure ES-1.) Wisconsin also produces emissions through the consumption of electricity generated in other states.

**Figure ES-1. Wisconsin Carbon Dioxide Pollution by Sector, 2004**




- Wisconsin 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. Energy Information Administration (EIA), Wisconsin's emissions of carbon dioxide from energy use could increase by 16 percent over 2004 levels by 2020, with increases in emissions from electricity generation responsible for the bulk of emissions growth.

**Wisconsin has already committed to several actions that will curb the growth of carbon dioxide emissions by 2020.** Over the past several years, Wisconsin has taken important steps to limit global warming emissions from power plants and to boost energy efficiency. Wisconsin's renewable electricity standard requires that 10 percent of the electricity sold in the state in 2015 come from renewable sources. Energy efficiency programs have helped reduce natural gas and electricity consumption.

**Wisconsin could reduce its contribution to global warming much further by adopting 13 key policy strategies.** There are numerous tools available to Wisconsin to reduce global warming pollution. The following policies can help the state reduce carbon dioxide emissions from energy use.

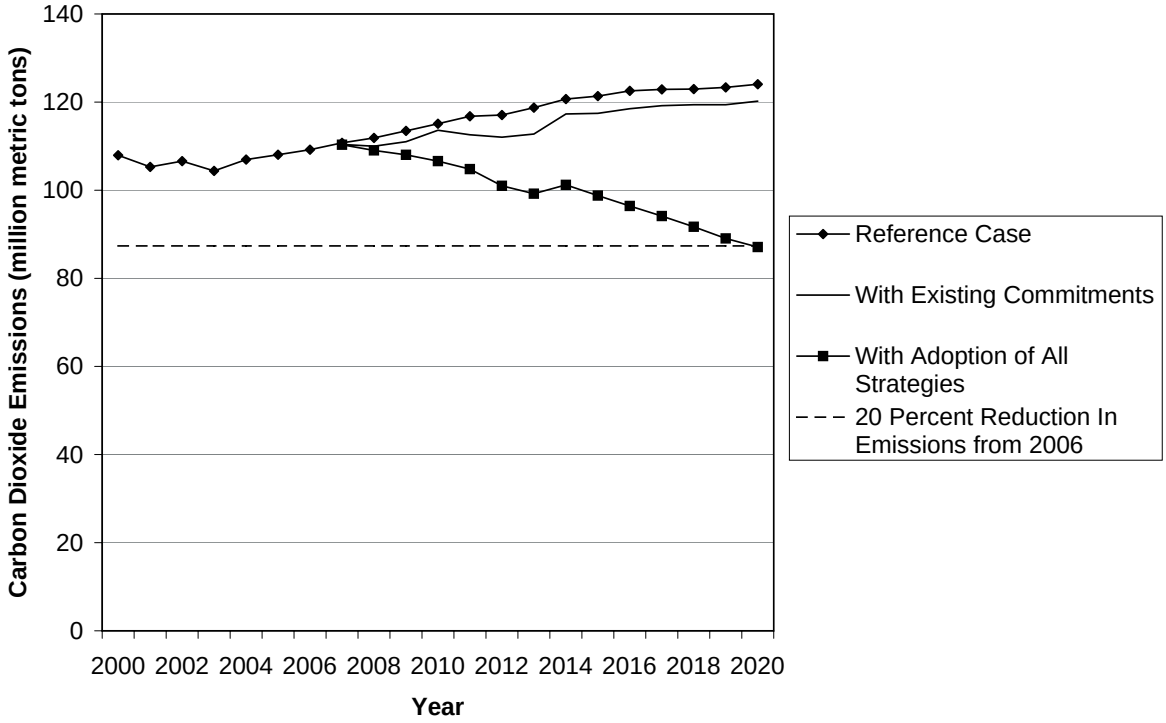
1. **Adopt the Clean Cars Program**. The Clean Cars Program will impose limits on vehicle carbon dioxide emissions and offer Wisconsinites a greater selection of hybrid-electric vehicles.
2. **Require energy-saving replacement tires**. By requiring the sale of energy-saving replacement tires, Wisconsin can improve vehicle efficiency without negatively affecting safety.
3. **Create mileage-based automobile insurance.** Automobile insurers should be required to offer insurance with rates based on the amount traveled. This will reward those who drive less and potentially reduce accidents.
4. **Reduce the number of automobile commutes**. Large employers should be required to develop programs to discourage single-passenger commuting and provide employees with more transportation choices to cut single-occupant vehicle commutes by 40 percent by 2020.
5. **Reduce the growth in vehicle miles traveled**. Wisconsin should invest in transit and reduce sprawling development to stop the per-capita growth in vehicle miles traveled by cars and light trucks on Wisconsin's highways.
6. **Adopt a low-carbon fuel standard**. A portion of motor fuel sold in Wisconsin should come from sources with lower life-cycle emissions than gasoline or diesel to reduce the carbon intensity of the fuel mix by 10 percent by 2020.
7. **Strengthen building energy codes**. Stronger energy codes for residential and commercial buildings would reduce energy use and thus global warming pollution.
8. **Adopt appliance efficiency standards**. Wisconsin should adopt energy efficiency standards for appliances and equipment.
9. **Increase investments in energy efficiency**. Investing more in energy efficiency would reduce electricity use by 0.7 percent and natural gas use by 0.4 percent annually.
10. **Encourage combined heat and power**. Wisconsin has the potential for 1,100 MW more of combined heat and power technology, which allows commercial and industrial facilities to use the same energy to generate both electricity and useful heat.
11. **Strengthen the renewable electricity standard**. Wisconsin should increase its existing renewable electricity standard to require that 20 percent of electricity comes from renewable sources by 2020.
12. **Prevent expansion of coal-fired power plants**. Wisconsin can avoid major projected increases in emissions by preventing the construction of new coal-fired power plants.
13. **Reduce government energy use**. Wisconsin should increase the energy efficiency of state government buildings, get 20 percent of its electricity from renewable sources by 2015, and reduce emissions from vehicles by 30 percent.

Adoption of these strategies would reduce global warming pollution while improving Wisconsin's energy efficiency. (See Figure ES-2 and figure inside front cover of report.) By 2020, Wisconsin's emissions of carbon dioxide would be approximately 30 percent below projected 2020 levels and 23 percent below 2006 levels.

**Wisconsin should commit to reducing its emissions of global warming pollutants to levels consistent with those scientists believe are necessary to avoid catastrophic climate change**. Specifically, the state should:

- Commit to achieving reductions in global warming emissions of 20 percent by 2020 and 80 percent by 2050. Adoption of a strong cap on global warming emissions would ensure that Wisconsin begins to reduce its emissions now.
- Ensure the full implementation of emission-reduction policies already adopted.
- Adopt the 13 additional strategies recommended in this report.
- Take additional actions 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-2. Wisconsin's Carbon Dioxide Emissions from Energy Use after Adoption of Recommended Strategies**



# Introduction

Many natives of Wisconsin are concerned about global warming. Al Gore's film *An Inconvenient Truth*, summer floods bringing substantial property damage, and unusually poor ice-fishing resulting from slushy conditions and late freezes have drawn attention to the problems of global warming.

Our state's environment is threatened by rising temperatures and changing patterns of precipitation, which may impact the shorelines of the Great Lakes, threaten wildlife populations, and fundamentally change the makeup of our forests. Global warming could also present new threats to important Wisconsin industries such as shipping, forestry, agriculture, and tourism. And in a very real sense, the impacts of global warming threaten the character of our state. From trout fishing in the spring to boating or beach-going in the summer, and from vibrant fall foliage to snow and ice in the winter, Wisconsin is defined by its love for the outdoors. Global warming could change how Wisconsinites experience the outdoors forever.

There is good news: we still have time to prevent the worst impacts of global warming, in Wisconsin and around the world. Citizens, business leaders and government officials across the state have already begun to take action to reduce pollution that causes global warming. Governor Jim Doyle, for example, has convened a global warming task force to examine the impacts of global warming in Wisconsin and to propose solutions. Already, the state has adopted a renewable energy standard that sets an overall statewide renewable energy requirement of 10 percent by the end of 2015, and has established energy efficiency programs.

However, more must be done if Wisconsin is to avoid the worst effects of global warming. This report outlines policy options that can significantly reduce Wisconsin's global warming emissions. By implementing the strategies identified in this report, Wisconsin residents will drive vehicles that use less fuel and derive more of their energy from renewable sources, thus reducing Wisconsin's dependence on petroleum. Homes, busi-

nesses 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. By adopting a mandatory limit on global warming pollution from the Wisconsin economy, coupled with policies to improve energy efficiency and expand production of homegrown renewable energy, our state can take the lead in addressing the serious challenges posed by global warming.

Wisconsin must pursue major changes in order to do its share to curb global warming. This report demonstrates what these changes should look like in order to protect our state from global warming.

# Global Warming and Wisconsin

## Global Warming Is Happening

Global warming threatens Wisconsin's future health, well-being and prosperity. The first signs of global warming are beginning to appear in Wisconsin and throughout the world. Global temperatures and sea levels 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 1.3°F (0.74°C).[1] (See Figure 1.) While this increase may not seem extreme, it is

**Figure 1. Global Average Temperatures, Difference from 1961-1990 Average[3]**

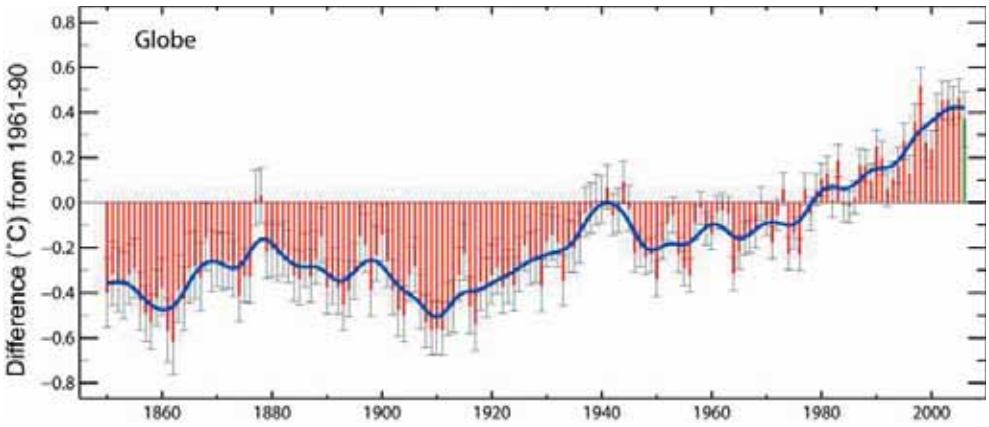
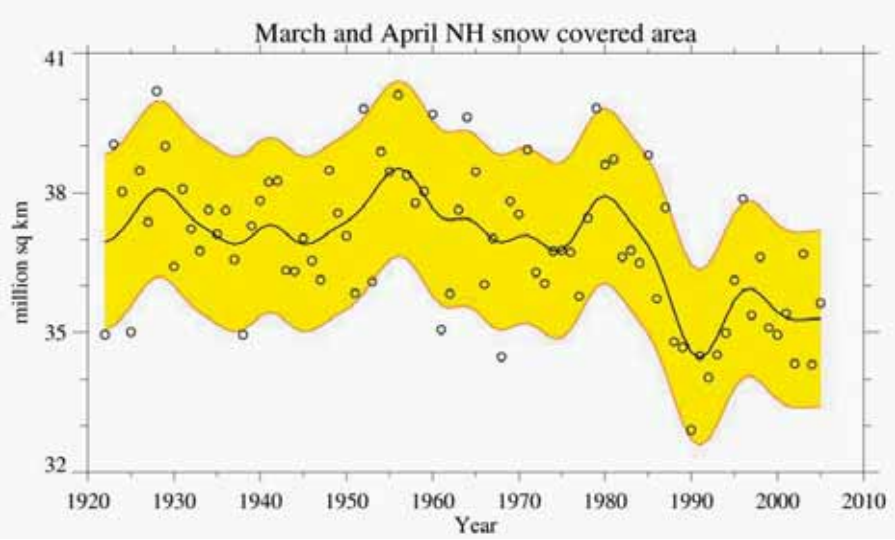


**Figure 2. Trends in Northern Hemisphere Snow Cover**[11]




unprecedented in the context of the last 1,300 years of world history.[2] 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.

Global warming has intensified in recent years. In 2006, scientists at the National Aeronautics and Space Administration (NASA) reported that, since 1975, temperatures have been increasing at a rate of about 0.36°F per decade.[4] Nationally, six of the last 10 years (1997 to 2006) rank among the 10 warmest years on record.[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. Glaciers are retreating around the globe and the annual extent of Arctic sea ice has declined by 2.7 percent per decade since 1978.[7] NASA scientists recently found a 23 percent decrease in the extent of Arctic sea ice over the past two winters.[8] The volume and extent of ice cover in the Arctic has been declining so rapidly that the Arctic could be ice-free during the summer by the end of this century.[9] Snow cover in the Northern Hemisphere has declined over the last several decades, dropping by 5 percent during the 1980s.[10] (See Figure 2.)

## 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 6.7 inches in the past century.[12] Sea level rise has already helped cause the inundation of some coastal land. Louisiana loses approximately 24 square miles of wetlands each year, causing an increase in the destructive potential of hurricanes like Hurricane Katrina.[13] 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.

### Shifting Seasons and Species on the Move

Worldwide, spring events—such as leaf unfolding, egg laying and bird migration—are occurring earlier in the year. In addition, numerous species of plants and animals appear to be moving toward the poles in response to rising temperatures.[14]

### More Severe Storms

Storms may be getting more intense. For example, an increase in the fraction of rainfall occurring as heavy precipitation events has been observed, a potential result of warmer air that is able to hold more moisture.[15]

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.[16] Existing hurricane observations indicate that the number of Category 4 and Category 5 hurricanes has increased substantially worldwide over the last 35 years.[17] 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).[18]

### Climate Change in Wisconsin

Wisconsin's climate has changed significantly over the past century as the state has been getting hotter. Average temperatures in Wisconsin increased by 0.7°F during the 20th century.[19] Extreme rainfall events became more common in the latter two-thirds of the 20th century, particularly in eastern Wisconsin.[20]

## 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 activity.[21] 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.[22] Concentrations of other global warming pollutants have increased as well. (See Figure 3.)

## 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 our emissions of global warming pollutants quickly and rapidly. Global warming will have serious impacts on Wisconsin's natural environment and thus its economy and way of life.

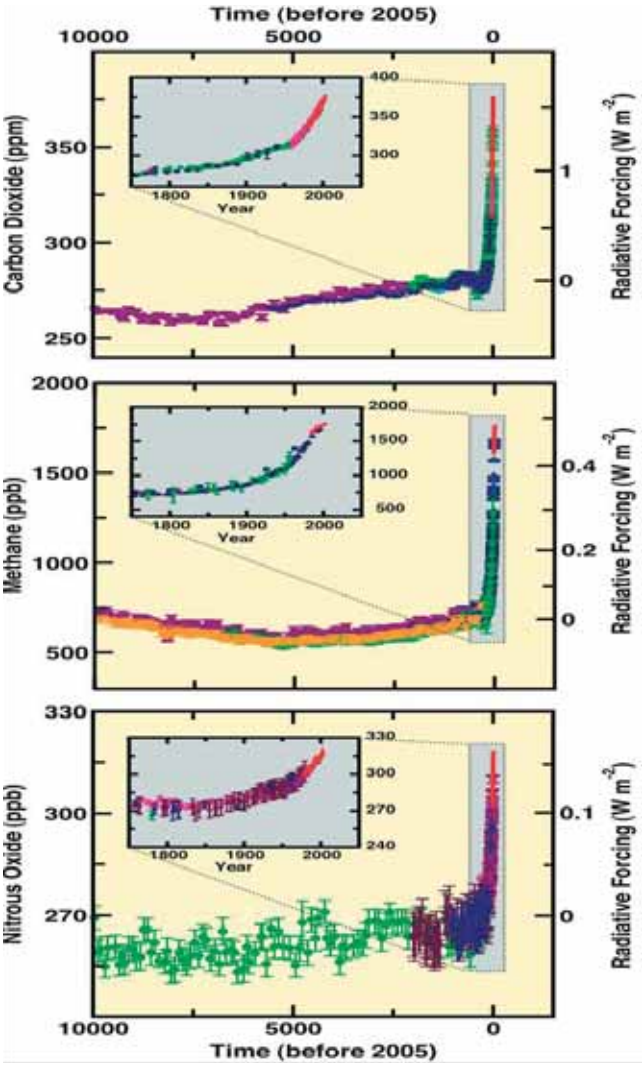
### Future Global Impacts

Many scientists and policy-makers (such as the European Union) recognize a 2˚C (3.6˚F) 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.[27] 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.[28]

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 over the next millennium (and possibly much faster)[29];
- 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;

**Figure 3. Atmospheric Concentrations of Global Warming Pollutants**[23]




ppb = parts per billion. Radiative Forcing = A measure of the balance between solar radiation entering into the atmosphere and the radiation leaving. An increase in radiative forcing indicates that more radiation is retained within the earth's atmosphere, thus contributing to global warming.

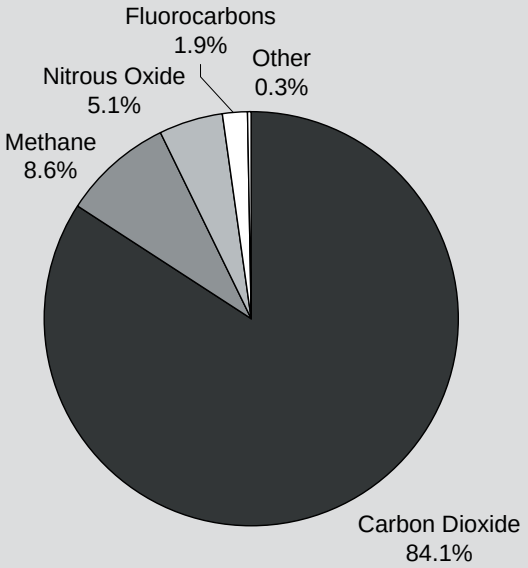
- Greater risk of positive feedback effects—such as the release of methane stored in permafrost—that could lead to even greater warming in the future.[30]

## 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 2005, carbon dioxide emissions represented approximately 84 percent of the U.S.'s annual contribution to global warming.[24]
- **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. It is responsible for about 5 percent of the U.S.'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.[25]

**Figure 4. U.S. Global Warming Emissions by Pollutant (carbon dioxide equivalent)**[26]



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 rise in sea level;
- Major crop failures in many parts of the world;
- Extreme disruptions to ecosystems.[31]

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

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 2007 Fourth Assessment Report, laid out a scenario in which population, economic output and fossil fuel consumption continue to grow dramatically. Under that scenario, global average temperatures by the end of the century would be approximately 4.0°C (7.2°F) higher than in 1990, and temperatures would continue to rise for generations to come.[32]

## Future Wisconsin Impacts

Wisconsin is especially vulnerable to the impacts of global warming, particularly due to the way the state's identity and economy are linked to its natural resources.

The Midwest region's climate is expected to grow warmer, with temperatures increasing by another 2 to 11.5°F above late 20th century levels by 2100.[33] Precipitation is projected to increase in the spring and winter while decreasing in the summer.[34] Correspondingly, the risk of extremely wet springs and extremely dry summers is also expected to increase over time.[35]

### Shrinking Great Lakes

Most (but not all) scientific models predict that water levels in the Great Lakes will decline as a result of global warming.[36] Many climate scientists believe that significant declines in water levels—on the order of 1.5 to 3 feet—may be observed by 2030, and that over the next century, water level in Lake Michigan could decline by 5 feet or more.[37] Low lake levels make it difficult for shipping firms to navigate shallow waterways, resulting in costly dredging operations as well as the need to rebuild or relocate shoreline infrastructure.[38] From an environmental perspective, a long-term shift toward shallower, smaller Great Lakes could change or dry up wetlands that provide spawning habitat for 120 species of fish.[39]

Warming temperatures will also decrease the winter ice cover on lakes, and ice cover plays an important role in maintaining water levels in the Great Lakes and sustaining a healthy ecosystem.[40] Longer periods without ice cover could extend the period during which rapid evaporation occurs, further decreasing water levels.[41] Declining ice cover also contributes to the warming of the Great Lakes, which may create problems for fish and other aquatic life in the lakes. Declining ice cover and warming lake temperatures combine to deplete oxygen from deeper portions of the lakes, creating "dead zones."[42]

The decline in lake levels and ice cover associated with global warming would have myriad consequences for Wisconsin's economy. In addition to the impacts on the shipping industry already mentioned, recreational activities such as

snowmobiling, ice-fishing and skiing will be threatened by global warming, thus harming the state's important tourism industry.[43]

### Rivers, Streams and Inland Lakes

Global warming could cause more floods like those that have destroyed property and damaged crops in Wisconsin over the past decade. Flooding in Wisconsin caused $14.7 million in property damage in 2006.[44] One particularly bad storm in August 2007 caused $48 million in damage.[45] Warmer and wetter winters could result in increased streamflows during the springtime due to increased precipitation and rapid snow melt. Coupled with scientists' predictions of an increase in extreme rain events, this could result in an increase in flooding on rivers, streams and lakes, causing erosion, water quality damage from runoff and sewer overflows, and damage to crops and property.[46]

On the other hand, hotter, drier summers could cause rapid evaporation of water from soils and waterways, causing small headwaters streams to dry up completely, starving crops of needed moisture, and lowering groundwater tables and the water levels of inland lakes.[47]

These competing phenomena will disrupt the aquatic ecology of Wisconsin, placing serious stress on fish and other wildlife in the state's rivers and lakes.

### Forests

As temperatures increase in Wisconsin over the coming decades, tree species that once thrived in the state will find that their ideal growing conditions have shifted to the north. Wisconsin could lose at least five species of trees—balsam fir, paper birch, white spruce, jack pine and red pine—by 2200 given anticipated levels of warming.[48] These species account for 12 percent of Wisconsin's forests, and losing them would represent a substantial change to Wisconsin's forested areas.[49]

Warmer temperatures could also exacerbate two other threats to Wisconsin's forests: fire and pests. Fire is a natural part of forest ecosystems, but hotter, drier summers could make forest fires more frequent and severe.[50] Moreover, global warming-induced shifts in bird populations could increase forests' susceptibility to insect pests those birds once feasted on.[51]

In addition to environmental concerns relating to global warming's effect on forests, global warming has an economic dimension: Wisconsin's forests support vigorous tourism and forestry industries. Forests cover nearly half of Wisconsin's land area, providing recreational opportunities to hikers, skiers, snowmobilers and hunters.[52] Forestry in Wisconsin employs about 70,000 workers and accounts for annual sales of $18 billion.[53] These critical sectors of Wisconsin's economy could be harmed if global warming is not addressed.

### Tourism and Recreation

As alluded to above, global warming will change the way Wisconsin residents enjoy the outdoors. Tourists, who travel long distances to take advantage of hunting, fishing, hiking and other recreational activities, spent nearly $12 billion in Wisconsin in 2005, helping to sustain more than 300,000 jobs.[54] Moreover, higher temperatures and warmer and shorter winter seasons could be detrimental to the favored pastimes of skiing, snowmobiling, and ice-fishing, damaging the tourism industry.

### Farming

Global warming could have myriad negative effects on Wisconsin's agricultural sector. First, higher temperatures cause heat stress in dairy cattle, resulting in diminished milk production; studies suggest that heat stress already costs the state's dairy industry $60 mil-

lion per year.[55] Furthermore, higher summer temperatures are projected to increase evaporation of water from farm soils, thus leading to increased potential for drought. Summer droughts could have significant negative impacts on Wisconsin's agricultural economy—for example, the state's 2003 drought caused an estimated $25 million in crop damage in Pierce County alone.[56]

The flip side of Wisconsin's increased susceptibility to summer drought is the potential for increased soil erosion caused by heavy storms. Increases in heavy precipitation events could lead to dramatic increases in soil loss by mid-century, particularly in eastern and southwestern Wisconsin.[57]

## 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 global warming pollutants must be held below 450 parts per million (ppm) in carbon dioxide equivalent.[58] Given that the concentration of global warming pollutants is already 427 ppm and rising every year, the need for action is immediate.[59]

To stabilize carbon dioxide levels between 445 and 490 ppm (carbon dioxide equivalent), global emissions must peak no later than 2015 and decline by 50 to 85 percent below 2000 levels by 2050.[60] 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—at least 80 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, Wisconsin can reduce its significant contribution to global warming.

# Global Warming Pollution in Wisconsin

Wisconsin is a significant contributor to global warming, mainly through the release of carbon dioxide resulting from consumption of fossil fuels. In 2004, the last year for which complete data are available, the use of energy in Wisconsin was responsible for the release of approximately 106.7 million metric tons of carbon dioxide, the leading global warming pollutant.[61] Were Wisconsin its own country, it would have ranked 37th in the world for emissions during 2004, ahead of nations such as Austria and Portugal.[62]

Wisconsin'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 Wisconsin'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 2004, carbon dioxide emissions from energy use in Wisconsin increased by 22.0 million metric tons of $CO_2$ ($MMTCO_2$)—or about 25.9 percent—a rate of increase higher than that of the U.S. as a whole, which has seen carbon dioxide emissions increase by 18 percent during that same period.[63]

Wisconsin'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 Wisconsin has already committed to implement), the state's carbon dioxide emissions could be expected to increase by 16 percent over 2004 levels by 2020.

Over the next 15 years, Wisconsin's emissions from all sectors of the economy can be expected to increase, with

the greatest increase taking place from electricity generation. Emissions from electricity generation are projected to increase by 11.3 $MMTCO_2$ (25.3 percent) from 2004 to 2020. Carbon dioxide pollution from the transportation sector can be expected to increase by 3.4 $MMTCO_2$ (11.1 percent), with smaller gross increases in emissions resulting from direct use of fossil fuels in the industrial (1.17 $MMTCO_2$ or 7.3 percent), commercial (0.84 $MMTCO_2$ or 14.9 percent), and residential (0.58 $MMTCO_2$ or 6 percent) sectors. (See Figure 5.)

## Sources of Carbon Dioxide Emissions in Wisconsin

A coherent strategy to address global warming pollution in Wisconsin must begin from an understanding of the sources of the pollution. Electricity generation is the leading source of global warming emissions in Wisconsin and will continue to be so in the coming years. However, pollution from all sectors of the economy is projected to increase to varying degrees over the next 15 years.

### Electricity Generation

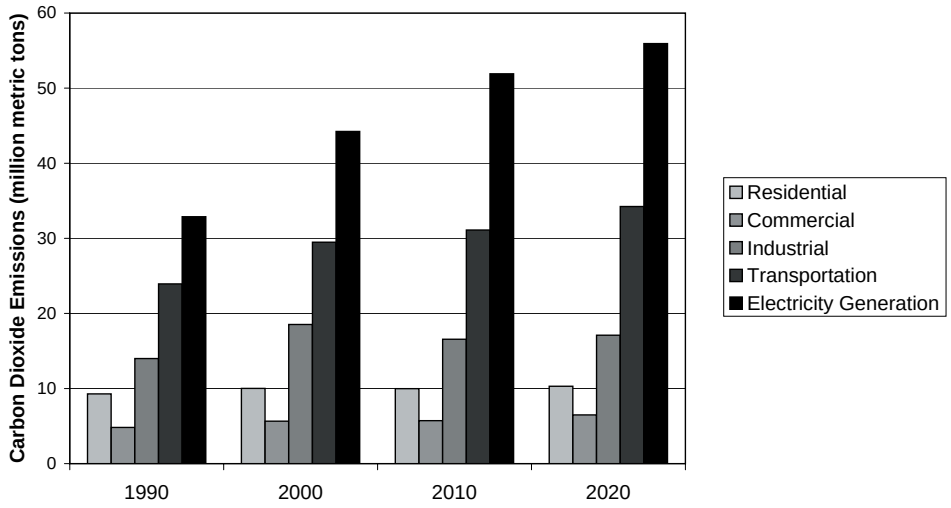
Power plants are the largest source of carbon dioxide emissions in Wisconsin, responsible for about 41.7 percent of the state's emissions. Adding in emissions from out-of-state power plants that supply electricity to Wisconsin would increase global warming pollution from Wisconsin's electricity consumption by 18 percent. Emissions from electricity generators in Wisconsin increased by 35.7 percent between 1990 and 2004.

The vast majority of global warming emissions from electric generation in Wisconsin come from coal-fired power plants. (Wisconsin's nuclear power plants, which generate slightly more than 15 percent of the power produced in the state, produce no direct carbon dioxide emissions, but do have significant environmental and public safety impacts. See "Nuclear Power in Wisconsin," page 21.) The state's coal-fired power plants produce nearly 96 percent of carbon dioxide emissions from power generation in Wisconsin, despite the fact that those plants produce only 71.6 percent of the power generated in the state.

### Transportation

Wisconsin's second largest source of carbon dioxide emissions is the transportation sector. In 2004, transportation accounted for 28.8 percent of the state's energy-related carbon dioxide emissions.

**Figure 5. Historic and Projected Wisconsin Carbon Dioxide Emissions**



Between 1990 and 2004, global warming pollution from transportation increased by 28.7 percent.

Personal vehicles such as cars, pick-up trucks and SUVs are the main sources of global warming pollution in Wisconsin, accounting for 66 percent of the state's transportation-related emissions.[64] The number of miles traveled on Wisconsin's highways increased by 36 percent from 1990 to 2004, to more than 60 billion miles per year.[65] Population growth accounts for some of the increase, but the number of vehicle-miles traveled per capita has also increased by 20 percent between 1990 and 2003.[66]

Over the next decade and a half, global warming pollution from gasoline consumption in Wisconsin (most of it used in cars and light trucks) is expected to increase by approximately 8.6 percent, while consumption of diesel fuel (used primarily in heavy-duty trucks) is poised to increase by 21.2 percent. Emissions from aviation are expected to rise 22 percent. Reducing global warming emissions from Wisconsin'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 and aviation emissions required as well.

### Residential, Commercial and Industrial Energy Use

Industrial energy consumption, which includes agricultural energy consumption, accounted for 14.6 percent of Wisconsin's carbon dioxide emissions in 2004 (excluding electricity use). Carbon dioxide emissions from industrial energy use increased by 13.9 percent between 1990 and 2004. Electricity consumption increased faster than consumption of other fuels, with Wisconsin industry consuming 41.4 percent more electricity in 2004 than it did in 1990. Carbon dioxide emissions from industry are expected to increase by 7.3 percent by 2020.

Direct consumption of fossil fuels in Wisconsin homes (again, not including electricity consumption) accounted for 9.3 percent of the state's carbon dioxide emissions in 2004. Emissions from the residential sector increased by 7.2 percent from 1990 to 2004. Household consumption of electricity increased by 29.3 percent, a rate of increase much greater than the state's 12.8 percent increase in population and part of the reason that carbon dioxide emissions from electricity generation increased over that period.[67]

Direct fossil fuel consumption in commercial buildings accounts for the remaining 5.3 percent of Wisconsin's carbon dioxide emissions. Carbon dioxide pollution from commercial buildings increased by 17 percent between 1990 and 2004. Electricity consumption increased as well, rising by 15.2 percent in commercial buildings over that time period, helping to fuel the increase in global warming emissions from electricity generators since 1990.

## Addressing Global Warming Pollution in Wisconsin

Wisconsin 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 Wisconsin'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 Wisconsin'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 Wisconsin on a trajectory toward further reductions in global warming pollution in the years to come.

## Nuclear Power in Wisconsin

About 16 percent of the electricity generated in Wisconsin comes from the state's three nuclear reactors—one at Kewaunee and two at Point Beach.[68] Initially licensed for operation in 1970, the first Point Beach reactor is one of the oldest nuclear reactors in the country.[69] Within the past five years, the Nuclear Regulatory Commission has approved requests from all three reactors to increase the official maximum level of generation at each facility.[70]

However, nuclear power poses a variety of public safety and environmental problems. The facilities should not be expanded and the existing units should be retired at the end of their operating licenses, if not sooner.

**Nuclear waste and terrorism:** The three reactors in Wisconsin each consume between 20 and 30 tons of uranium annually, producing thousands of spent fuel rods that must be disposed of.[71] However, in the absence of a national repository for nuclear waste, the spent nuclear fuel is stored in and near the plants. Some of the waste at Kewaunee and Point Beach is stored in water-filled pools; additional waste is kept in casks next to the plants.[72] This spent fuel is a potential target for terrorists and presents a safety threat.

Inspectors have found major safety concerns at the plants. Under the U.S. Nuclear Commission's (NRC) inspection system, "red" designates a problem of "high safety significance." According to an NRC press release, the Point Beach nuclear reactors were cited with violations related to water intake serious enough to be labeled "red" three times in 2002 and 2003, and have triggered a total of 12 safety violations in the past 10 years.[73] Kewaunee's reactor has received 10 citations in as many years, the two most recent violations being "yellow," the second-highest level of severity.[74]

**Cooling water and fish kills:** The reactors at Kewaunee and Point Beach are cooled by large amounts of water drawn from Lake Michigan, killing thousands of small fish annually when they are trapped on the screens filtering the water that enters the plants.[75] The water is discharged at elevated temperatures back into Lake Michigan; this change in temperature harms aquatic life.[76]

**Wisconsin: the next Yucca Mountain?** In 2000, President Bush approved Yucca Mountain, Nevada, as the nation's first high level nuclear waste disposal site. However, Yucca Mountain, when and if it ever opens, will already be too small a depository to handle America's nuclear waste effectively: the facility cannot legally hold more than 63,000 tons of commercial high level waste, and 45,000 tons exist already.[77] A second storage site will be necessary in the relatively near future, and it could be in Wisconsin. The Wolf River Batholith, a large rock body covering 5,800 square miles of northeastern Wisconsin, has been cited repeatedly as a potential location of a second nuclear waste disposal area.[78] Storing the nation's nuclear waste in Wisconsin would not only pose hazards for the Wolf River Batholith, but also would endanger roads, waterways, ports, and railways used to transport waste to the site.

The energy efficiency and renewable energy policies described in this report not only help Wisconsin to reduce its contribution to global warming, but can help reduce the state's dependence on its aging nuclear power plants.

By moving forward with a clean energy policy that emphasizes renewable energy development and improved energy efficiency, Wisconsin can meet 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.

# Global Warming Strategies for Wisconsin

## Commitments Already Made

Wisconsin has already begun to take action to head off future increases in global warming pollution. Over the past several years, the state has adopted several measures, such as increasing electricity generation from renewable sources of energy and improving energy efficiency, that, if fully implemented, will begin to reduce carbon dioxide emissions. The ultimate success of these measures, however, is not a given. Wisconsin has much work to do to ensure that the state's policy initiatives on global warming deliver real results.

### Renewable Electricity Standard

In October 1999, Wisconsin enacted a renewable electricity standard (RES). Initially, the RES required that 2.2 percent of electricity sold to Wisconsinites come from clean and renewable sources.[79] The standard was strengthened in 2006 to require that an increasing percentage of power sold in the state by utilities come from clean renewable sources, with the eventual requirement of generating a total of 10 percent of electricity from clean renewable power by 2015.[80]

Qualifying renewables include wind power, solar thermal electric and photovoltaics (PV), biomass (including landfill gas), fuel cells using renewable fuels, geothermal, hydropower less than 60 megawatts, and tidal and wave action. Renewable energy generated outside of Wisconsin is eligible.

The estimated savings in global warming pollution from Wisconsin's current renewable energy standard are 1.5 $MMTCO_2$ by 2020.

While Wisconsin's RES is an important first step in phasing in renewables in favor of dirtier sources of energy, it does not go far enough. Wisconsin should adopt a stronger version of the RES, mandating that 20 percent of electricity come from clean renewable energy by 2020.

### Energy Efficiency

Energy efficiency improvements are among the most promising and least costly ways to reduce global warming emissions.

In 1999, the Wisconsin Legislature required investor-owned utilities to pay a portion of their revenues into a public benefits fund for energy efficiency, renewable energy and low income household energy assistance programs. Legislators gave municipal and cooperative utilities the option of participating in this statewide program or creating their own programs.[81]

The state restructured the public benefits fund in March 2006 to protect the fund from raiding for other budget purposes. Currently, investor-owned electric and natural gas utilities are required to spend 1.2 percent of their annual revenues on programs to promote energy efficiency and renewable energy—either on their own, or using the statewide Focus on Energy program.[82] Focus on Energy offers technical and financial assistance to residential and commercial energy customers seeking to reduce energy use or develop small-scale renewable energy installations.

In fiscal year 2006, Focus on Energy spent $40 million. The program worked with more than 240,000 participants to save nearly 200 gigawatt-hours (GWh) of electricity (about 0.2 percent of annual consumption) and 13 million therms of natural gas (about 0.3 percent of annual consumption), primarily through energy efficiency, but also including renewable energy projects, saving participants more than $30 million per year on energy costs.[83]

In addition, Wisconsin recently passed energy efficiency and green building standards for state buildings. This policy states that public buildings should reduce their energy use 10 percent by next year, and 20 percent by 2010, and requires new state buildings be 30 percent more efficient than code.[84]

In terms of per-capita spending on energy efficiency (excluding load management), Wisconsin ranked 15th out of all U.S. states in 2006, and first in terms of per-capita spending on natural gas efficiency.[85]

Based on projected energy savings from Focus on Energy's programs, Wisconsin's current energy efficiency programs are expected to reduce global warming pollution by 0.8 $MMTCO_2$ by 2020.

These policies put Wisconsin on the right track toward reducing its global warming pollution. However, the state should strengthen these policies by pursuing more stringent building energy codes and increasing funding for energy efficiency programs.

### Total Impact of Commitments Already Made

The policies that Wisconsin has already adopted and that are not already included in the baseline emissions estimate—the renewable electricity standard, the Wisconsin Energy Conservation Code, the Focus on Energy Program, and the Energy Efficiency and Renewables Act—will reduce Wisconsin's emissions by approximately 3.8 $MMTCO_2$ versus the reference case in 2020.

## Strategies for Further Reducing Global Warming Emissions

Wisconsin has many strategies that it can pursue to reduce global warming emissions. The following 13 strategies are among those the state can use to improve the energy efficiency of its economy and significantly reduce global warming emissions.

## Transportation Sector Strategies

1. Adopt the Clean Cars Program.
2. Require energy-saving tires.
3. Implement pay-as-you-drive insurance.
4. Reduce the number of automobile commutes.
5. Reduce the growth in vehicle travel through smart growth and expanding transportation choices.
6. Establish a clean fuels standard.

### Strategy #1: Adopt the Clean Cars Program

**Potential Savings: 2.4 MMTCO$_2$ by 2020.**

Wisconsin can adopt the "Clean Cars Program" developed by the state of California and adopted by 11 other states, which will require significant reductions in global warming emissions from vehicle tailpipes.[86]

The federal Clean Air Act allows states whose air fails to meet health standards to choose between two sets of emission standards: those in place at the federal level and the traditionally tougher standards adopted by the state of California, known as the Clean Cars Program.

Over the last several decades, the Clean Cars Program has evolved to include three elements:

- Low-emission vehicle standards that require reductions in smog-forming and toxic pollutants.
- Advanced technology vehicle standards that spur the introduction of low-polluting, high-technology vehicles into the fleet, such as near-zero emission gasoline cars, hybrid-electric vehicles, and eventually electric or hydrogen fuel-cell vehicles.
- Tailpipe emission standards for global warming pollution.

Of the three components of the Clean Cars Program, the advanced technology standards and tailpipe emission standards for global warming pollution have the greatest potential to reduce global warming pollution from Wisconsin's transportation sector.

#### Advanced Technology Standards

While primarily a program for reducing smog-forming and toxic emissions from automobiles, the Clean Cars Program's "technology forcing" component will likely reduce carbon dioxide emissions by requiring the introduction of significant numbers of advanced technology vehicles (including hybrid-electric vehicles) and, eventually, electric hydrogen fuel-cell vehicles. Beginning in 2010 (when 2011 model year cars will go on sale), automakers would be required to sell the equivalent of approximately 15,000 hybrid vehicles per year in Wisconsin, with the numbers increasing over time. By 2020, as the program is currently designed, about 9 percent of new light-duty vehicles sold in Wisconsin would be hybrids, while about 1 percent would be hydrogen fuel-cell or other vehicles with zero emissions.[87]

Hybrid-electric vehicles have already proved popular with drivers in Wisconsin and elsewhere. Sales of hybrid-electric vehicles have increased steadily since their introduction to the domestic market in December 1999. About 250,000 hybrids were sold in the U.S. in 2006, 25 percent more than in the previous year.[88] Hybrid vehicle sales through October 2007 had already exceeded total 2006 sales.[89]

In its Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) model, the Argonne National Laboratory estimated that hybrid-electric passenger cars release

approximately 47 percent less carbon dioxide per mile than conventional vehicles. Fuel cell passenger cars operating on hydrogen derived from natural gas are projected to produce about 62 percent less carbon dioxide than conventional vehicles.[90] The requirements for these vehicles would likely produce a 1 to 2 percent reduction in global warming emissions from light-duty vehicles in Wisconsin.[91]

**Global Warming Emission Standards**

In 2002, the Clean Cars Program was expanded with the addition of a law calling for standards for carbon dioxide emission standards for motor vehicles. The Greenhouse Gas Emission Standards for Vehicles law was the first in the nation to regulate carbon dioxide for automobiles.

The legislation 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.[92] In September 2004, CARB adopted rules for implementation of the greenhouse gas emissions standards for vehicles. In addition, in 2006 California adopted legislation placing limits on global warming emissions from throughout the state's economy. This new law could lead to tightening of the vehicle global warming emission standards beyond 2016.

In estimating the benefits of the global warming and vehicles standards, we assume that Wisconsin vehicles will achieve the same percentage emission reductions as estimated by CARB—34 percent for cars and 25 percent for light trucks by 2016.[93] Adoption of the standards would lead to net consumer benefits of an estimated $10 per month for new car purchasers and $14 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 (assuming that gas costs $2.20 per gallon, well below current gas prices).[94]

Wisconsin can lay the groundwork for implementation of the global warming and vehicle standards by moving forward with full adoption of the Clean Cars Program.

**Strategy #2:**
**Require Energy-Saving Tires**

**Potential Savings:**
**0.2 MMTCO$_2$ by 2010;**
**0.5 MMTCO$_2$ by 2020.**

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.[95]

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 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, if feasible.[96] 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 Wisconsin to develop similar requirements.

A standards program that required the sale of LRR tires beginning in 2009 in Wisconsin—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 #3: Implement Pay-As-You-Drive Automobile Insurance

**Potential Savings: 0.4 MMTCO$_2$ by 2010; 0.5 MMTCO$_2$ by 2020.**

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.[97] 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 Wisconsin 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 Wisconsin—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 Wisconsin collision and liability insurance policy to a per-mile basis would lead to an average insurance charge of about 4.1 cents per mile.[98] (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 2.3 percent below projected levels, with carbon dioxide emissions from light-duty vehicles declining by roughly the same amount.[99]

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 offers a pilot PAYD insurance system in Michigan, Minnesota and Oregon, 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.[100]

Wisconsin 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 #4: Reduce the Number of Automobile Commutes

**Potential Savings: 0.3 MMTCO$_2$ by 2010; 1.1 MMTCO$_2$ by 2020.**

Commutes to and from work make up a major share of vehicle travel in Wisconsin. Nationally, about 28 percent of all vehicle miles are traveled on the way to or from work.[101] 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 Wisconsin's highways.

Wisconsin has already implemented a successful commute-trip reduction program at two major universities. Campus Transport Management programs have been effectively implemented at both University of Wisconsin-Madison and University of Wisconsin-Milwaukee. These programs include transit improvements, fare discounts, shuttle services, ridesharing, and expanded bicycle parking, and apply smart growth and new urbanist principles to on-campus devel-

opment that reduce the need for travel.[102] At UW Milwaukee, the Campus Transport Management has reduced student driving 26 percent since the program's inception.[103]

Several other programs support reduced driving by employees and could be incorporated into a mandatory employer-based commute-trip reduction program. Wisconsin's current commute-trip reduction tools include the RIDESHARE program in southeastern Wisconsin, which helps commuters find carpool partners.[104] Additionally, public and private employees who work in Madison can participate in a vanpool, in which the state Department of Administration provides a van and helps match commuters with others in their area.[105]

Mandatory employer trip reduction programs can be extremely effective. For example, Washington and Oregon enacted these policies in the 1990s, and subsequently were the only two states to experience a decrease in the percentage of drive-alone commuters during the 1990s.

Washington State's program was enacted in 1991 and covers employers with 100 or more full-time employees 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.[106] 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.[107]

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.[108] 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.[109]

A vigorous, mandatory trip reduction program for Wisconsin employers could achieve similar results. Wisconsin's existing trip-reduction services, coupled with the state's growing 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 2017. 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.
- 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, Wisconsin 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.

Wisconsin 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.[110] 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 #5: Reduce Growth in Vehicle Travel Through Smart Growth and Expanded Transportation Choices

**Potential Savings: 1.8 MMTCO$_2$ by 2020.**

Wisconsin's long-term transportation strategy must also halt the growth of vehicle-miles traveled (VMT), which has been increasing consistently across the state as a result of population growth, low gasoline prices (until recently), expansion of the workforce, and commercial and residential 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 Wisconsin's energy security, and reducing automotive emissions of other pollutants that harm public health. Wisconsin's population is projected to increase by about 450,000 residents by 2020 from 2005 levels (an increase of about 8.1 percent), creating challenges to any effort to reduce driving but also offering opportunities for new solutions.[111]

Stabilizing per-capita vehicle-miles traveled at today's levels would avoid a large projected increase in vehicle travel over the next 15 years. By holding future growth in vehicle travel to the rate of population growth, the number of vehicle miles traveled in Wisconsin would increase by about 6.8 percent between 2005 and 2020, compared with an approximate 14.6 percent increase in the reference case scenario.[112]

Ultimately, Wisconsin will need a greater reduction in driving by the state's

residents to achieve long-run global warming pollution reduction targets. The investments in transit, carpooling and better development patterns that Wisconsin makes to stabilize vehicle miles of travel in the next decade will contribute to a longer-term reduction in driving.

Wisconsin residents have already begun to cut back on driving as a result of higher fuel prices. Data from the Wisconsin Department of Transportation indicate that 1.1 percent fewer vehicle miles were driven on Wisconsin highways in 2006 than in 2005.[113]

Wisconsin should:

- **Expand and improve rail and bus transit systems statewide** – Currently, mass transit systems throughout Wisconsin are far from ideal. Both the Milwaukee and Madison metropolitan areas are planning to improve bus services and light rail, but these plans must be formulated, funded and implemented more quickly in order to address the urgent issue of global warming. The Milwaukee Connector Plan proposes a guided street tram and a hybrid bus system in an exclusive travel lane.[114] Residents of the Madison metropolitan area recently voted to make the construction of commuter rail service in the existing rail corridor a central part of the region's long-term transportation plan for the Madison area.[115] Commuter rail service should also be established between Kenosha, Racine and Milwaukee, enhancing existing rail facilities and allowing tens of thousands more commuters to ride the train instead of drive.

  Creation of regional transit authorities (RTAs) would allow improved fundraising and transit planning to serve connected municipalities, rather than just single cities.

  Smaller communities need better bus service to carry residents to major retail and employment centers from low- and medium-density neighborhoods. Shuttle service from residential neighborhoods to transit stops can connect more people to transit. Frequent, convenient service is essential for drawing new riders.

- **Restrain exurban sprawl** – In 1999, Wisconsin passed a landmark "Smart Growth" law that defined a comprehensive plan for land use effective in 2010, featuring a comprehensive planning grants program and stressing citizen involvement.[116] The bill outlines the nine elements that all local governments must incorporate into expansion projects, and provides flexibility in addressing statutory requirements.

  Meanwhile, sprawling growth continues to be a problem in Wisconsin, particularly in the Milwaukee and Madison metropolitan areas. New developments stretching farther from city centers bring more traffic to highways and exacerbate global warming through ever-longer commutes. Wisconsin should work to ensure that new growth takes place in a way that minimizes demand for highway travel and encourages development in already built-up areas with existing or planned transportation infrastructure.

- **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. 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 consideration of the impact on global warming emissions of all new transportation projects, so that Wisconsin residents can evaluate the impacts of various transportation choices on the climate.

By focusing on the development of vibrant, compact communities whose residents have access to a variety of convenient, affordable transportation options, Wisconsin 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 #6: Adopt a Low Carbon Fuel Standard

**Potential Savings: 3.3 MMTCO$_2$ by 2020.**

Wisconsin can reduce its petroleum dependence, while reducing global warming pollution, by enacting a low-carbon fuel standard. A low-carbon fuel standard would require that increasing amounts of fuel sold in Wisconsin come from sources with lower life-cycle global warming emissions than gasoline or diesel.

Fuels with lower life-cycle carbon emissions than gasoline and diesel may include ethanol, biodiesel, electricity, and hydrogen. Biofuels are typically made from such crops as corn and soybeans. Technology that would allow cellulose from plant residues or "energy crops" (such as switchgrass) to be turned into fuel holds the promise of even greater energy and global warming pollution benefits. The carbon emissions of biofuels depend on how they are produced, including pesticide use, farming practices, processing method, and transportation to consumers. For electricity and hydrogen, life-cycle carbon emissions are most affected by the fuel used to generate power or produce hydrogen fuel.

Renewable fuels currently are mixed with petroleum-based fuels, such as gasoline or diesel. Blends with low percentages of biofuels can be used in virtually all vehicles, but this can lead to increases of some air pollutants. To run a vehicle on higher percentages of ethanol requires simple and inexpensive modifications to the vehicle's engine.

Plug-in hybrid cars and hydrogen vehicles have not yet been commercialized, but automakers are demonstrating the feasibility of these technologies through small-scale trials. A low-carbon fuel standard would encourage development of less polluting fuels, the vehicles that use them, and a new fuel distribution infrastructure.

Wisconsin should establish a goal of reducing the carbon content of the state's vehicle fuel mix by 10 percent by 2020. The standard could be implemented beginning in 2011 with a 1 percent reduction, and increasing by 1 percent per year. This gradual implementation will allow for development of technologies to create biofuels from cellulose and construction of a distribution network.

California recently adopted a similar low-carbon fuel standard.[117] The state expects that the standard will replace 20 percent of the state's gasoline consumption with lower-carbon fuels.[118] A number of other states require the use of renewable fuels, though these standards do not directly target global warming pollution. Nonetheless, they demonstrate the feasibility of increasing the production and distribution of fuels with potentially lower global warming emissions.[119]

## Making Biofuels Sustainable

Ethanol, biodiesel and other biomass-based fuels can make a significant contribution to reducing global warming pollution—if they are produced sustainably. However, environmental damage can result if the transition to biofuels is managed poorly. Indeed, under some circumstances, production and use of biofuels could lead to greater global warming emissions than the petroleum products they are designed to replace.

To maximize the environmental benefits of biofuels, policies must be in place to ensure that they are developed sustainably.

- **Protect air quality** – Low concentrations of ethanol in gasoline (such as E10) can result in increased emissions of smog-forming pollutants.[122] Motor vehicle air pollution standards should be revised to ensure that the use of ethanol does not result in overall increases in urban smog. In addition, public policy should encourage the use of ethanol fuels in higher blends (such as E85), which do not pose a threat to air quality. Tailpipe emissions from vehicles using higher blends may be lower than vehicles using conventional fuels, but ethanol refineries may release greater pollution. Care must be taken not to create new hot spots of pollution.

- **Ensure sustainable production** – The way biofuels are produced has a large impact on their ultimate environmental benefits. Some agricultural methods for producing biomass can contribute to environmental problems such as nutrient enrichment of waterways and soil erosion.[123]

  Under some production methods, biofuels can provide negligible global warming benefits or even result in higher global warming emissions. For example, the high price of natural gas has led some ethanol producers to use coal as a fuel for their plants, a change that could reduce, or even eliminate, the global warming benefits of ethanol use.[124] To reduce emissions during production, biomass power could replace fossil fuels such as coal or natural gas.

  Some biomass production methods can also lead to increases in global warming emissions from land use that reduce or cancel out the benefits from reducing consumption of fossil fuels.[125] Finally, increasing production of feedstocks for biofuels could encourage negative agricultural practices (such as broader use of genetically modified crops or applications of toxic pesticides) or the conversion of ecologically important areas to energy crops.

  A sustainable biofuels strategy must recognize these challenges and ensure that the agricultural and industrial processes used to produce biofuels do not cause unintended harm to the environment or the climate.

- **Don't substitute biofuels for efficiency improvements** – Biofuels can provide an important supplement to fossil fuels, but they are no substitute for using energy more efficiently. The "dual-fuel" loophole in U.S. automobile fuel economy standards, for example, gives automakers credit toward their fuel economy goals for the production of vehicles that are capable of running on alternative fuels such as E85, even though the vast majority of dual-fuel vehicles are operated entirely on gasoline.[126] Public policy should drive *both* improvements in fuel economy and sustainable expansion of biofuels in order to reduce fossil fuel use and achieve reductions in global warming pollution.

Wisconsin has enormous potential in low-carbon fuels, making a low-carbon fuel standard entirely feasible. Wisconsin alone has almost 15 million tons of potential biomass that technically could produce 1.3 billion gallons of ethanol per year and could displace one-third of the 2.6 billion gallons of gasoline Wisconsin consumed in 2006.[120] This is in addition to 252 million gallons of current corn ethanol production in Wisconsin.[121]

As Wisconsin moves forward with a low-carbon fuel standard, it is important that the state make policy decisions that maximize the benefits of the standard and limit environmental hazards. The state should ensure that implementation of the fuel standard does not adversely affect air quality. To encourage the use of higher-percentage blends of ethanol (such as E85), the state should ensure that "flex-fuel" vehicles are able to take full advantage of their potential for using renewable fuels by encouraging construction of adequate refueling infrastructure. (See "Making Biofuels Sustainable.")

### Other Transportation Strategies

The six strategies discussed above will help reduce emissions from transportation, but there are more ideas that Wisconsin could pursue. Some are approaches that the state could adopt by itself, but others will require regional or federal action.

## *Offer Financial Incentives for Vehicle Efficiency*

Wisconsin 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. However, adoption of a feebate program would provide yet another tool for Wisconsin to use in promoting a shift toward vehicles with less impact on the global climate.

## *Advocate for Heavy-Duty Truck Federal Fuel Economy Standards*

Heavy-duty trucks are major consumers of fuel. Large tractor-trailers consumed about 14 percent of the fuel used by all highway vehicles nationally in 2004, and fuel consumption by large trucks has been increasing by more than 4 percent per year since the early 1990s.[127] 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.[128]

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.[129] Calculations of cost-effectiveness were based on diesel fuel prices of $1.41 to $1.60 per gallon, well below the recent prices of $2.79 and higher charged recently at pumps across the United States.[130] 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. Wisconsin should call upon the federal government to improve the fuel economy of trucks.

## Residential, Commercial and Industrial Sector Strategies

7. Strengthen residential and commercial building energy codes.
8. Adopt stronger energy efficiency standards for appliances.
9. Strengthen electricity efficiency programs.
10. Expand combined heat and power.

### Strategy #7: Strengthen Residential and Commercial Building Energy Codes

**Potential Savings**
**If policy is enacted alone:**
**0.5 MMTCO$_2$ by 2010;**
**0.7 MMTCO$_2$ by 2020.**

**If policy is enacted with others in this report*:**
**0.5 MMTCO$_2$ by 2010;**
**3.1 MMTCO$_2$ by 2020.**

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. Because residential and commercial buildings can last for decades, adopting and enforcing strong building codes is crucial for avoiding excessive energy consumption over the long term.

---

* Savings from this policy are greater when it is adopted in conjuction with all the other policies recommended in this report because of our assumption that the Kewaunee nuclear power plant will close down when its license expires at the end of 2013. When the plant is retired, reduced electricity demand or increased renewable electricity production is assumed to replace the power that was generated at Kewaunee rather than to result in less natural gas or coal-fired generation. Offsetting nuclear generation rather than fossil fuel-driven generation results in no emission savings.

The electricity savings from this single policy are too small to offset both the full capacity of the Kewaunee plant as it is retired and some fossil fuel-driven generation that would result in an emissions reduction. However, when all the policies in the report are adopted together, they easily offset the nuclear generating capacity at Kewaunee and significant amounts of coal-fired generation. The resulting emission savings are attributed to individual policies in proportion to the electricity reduction each produces.

Wisconsin's current energy code is relatively weak, but an updated, stronger commercial version is being developed. Currently, the state relies upon a variation of the 1995 Model Energy Code (MEC). The code is so weak that only five states have weaker codes (another five have no codes at all).[131] Commercial buildings are subject to the 2000 International Energy Conservation Code (IECC), also a relatively weak standard.[132]

In 2006, the Wisconsin Legislature enacted a law that requires the Department of Commerce to write energy efficiency codes for new non-residential buildings and to update these codes every three years.[133] However, there is no move to update the residential code.

Wisconsin can do far more to reduce energy use and global warming pollution from all buildings. The state should pursue aggressive, mandatory building codes with strong enforcement mechanisms in order to reduce emissions that cause global warming. The global warming pollution reductions projected here assume that Wisconsin adopts a residential code equal to the current Energy Star standard, beginning in 2010 and that the code becomes stronger over time. "Energy Star" homes are 15 percent more energy efficient than homes built to the 2004 International Residential Code and on average are 20 to 30 percent more efficient than standard homes.[134] On the commercial side, we assume that energy codes capable of reducing energy consumption by 25 percent from the 2006 IECC are adopted, effective in 2010.

Wisconsin can also encourage voluntary measures to construct buildings that are more efficient than the code requires. In 2006, fewer than 10 percent of new homes in Wisconsin were certified as Energy Star homes, but in some states, such as Iowa, as many as 57 percent of homes were built to Energy Star standards.[135]

If implemented, these improvements in building code policy could reduce electricity use by 3.3 percent and natural gas by 2.7 percent by 2020, resulting in a 0.7 $MMTCO_2$ reduction in global warming emissions.

### Strategy #8: Adopt Strong Appliance Efficiency Standards

**Potential Savings**
**If policy is enacted alone:**
**0.2 $MMTCO_2$ by 2010;**
**0.1 $MMTCO_2$ by 2020.**

**If policy is enacted with others in this report*:**
**0.2 $MMTCO_2$ by 2010;**
**0.9 $MMTCO_2$ by 2020.**

* See footnote on p. 34 for explanation of different savings figures.

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

Wisconsin has the power to adopt energy efficiency standards for a range of residential and commercial appliances. The adoption of state-level appliance efficiency standards pushed the U.S. Congress to include federal energy efficiency standards for 15 new appliances in the 2005 Energy Policy Act. However, new energy efficiency technologies for appliances continue to be developed and Wisconsin has an opportunity to adopt stronger standards for appliances that were not covered in the 2005 federal law. Appliances for which new standards would be appropriate, either now or in the near future, include:

- Residential furnaces and boilers
- Commercial hot food holding cabinets, walk-in refrigerators and freezers
- DVD players and recorders
- External power supplies for consumer electronics
- Compact audio products
- Bottle-type water dispensers.[136]

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 Wisconsin would reduce electricity demand by 1,137 gigawatt-hours (GWh) in 2020, reduce natural gas demand by 2,725 million cubic feet, and save Wisconsin more than $103 million over time.[137]

The emission reductions estimated for this scenario assume that Wisconsin adopts all of the efficiency standards recommended by ACEEE and ASAP in 2009 or 2012, depending on the appliance (see methodology for details). Further reductions will be possible in future years as new technologies allow appliance efficiency standards to be tightened over time.

### Strategy #9: Strengthen Energy Efficiency Programs

**Potential Savings**
**If policy is enacted alone:**
**0.7 MMTCO$_2$ by 2010;**
**0 MMTCO$_2$ by 2020.**

**If policy is enacted with others in this report*:**
**0.7 MMTCO$_2$ by 2010;**
**2.7 MMTCO$_2$ by 2020.**

* See footnote on p. 34 for explanation of different savings figures.

One of the most promising opportunities for reducing carbon dioxide emissions in Wisconsin is through improved energy efficiency. Residential and commercial building codes and improved appliance efficiency standards, while important, are limited in their scope, leaving many existing buildings and sources of energy untouched. Stronger energy efficiency programs for residential, commercial and industrial energy users can help cut carbon dioxide emissions in Wisconsin.

Residential and commercial efficiency savings can be achieved with more efficient lighting, better insulation and weathersealing of buildings, and more efficient furnaces, air conditioners, and other appliances. In the industrial sector, potential efficiency improvements include more efficient motors, furnaces, ovens, cooling and drying systems, and compressed air systems. More than two-thirds of electricity use in industry is for electric-powered motors.[138] In addition to installing more efficient motors, industrial facilities can improve the efficiency of motor systems by sealing ducts and pipes and optimizing systems. Better sensors and controls can time manufacturing processes to use the least energy.

The Focus on Energy program (discussed earlier in "Commitments Already Made") is Wisconsin's major statewide energy efficiency initiative, with efficiency efforts that aid all energy users in reducing their energy consumption. Utilities in Wisconsin must pay 1.2 percent of their annual operating revenue to support energy efficiency or operate a comparable program of their own.[139] In fiscal year 2006, Focus on Energy spent $40 million on energy efficiency, reducing electricity consumption by 0.2 percent and natural gas consumption by 0.3 percent.[140]

However, current funding levels for Focus on Energy fail to capture all of the state's energy efficiency potential.

Data presented in several studies by ACEEE suggest that potential energy efficiency savings are great enough to reduce energy use, not simply reduce the rate of growth in energy use. ACEEE compared the results of energy efficiency potential studies in states and regions across the country. On average, those studies found that electricity use could be reduced cost effectively by 24 percent through energy efficiency over a period of 10 to 20 years.[141] The ACEEE study also included estimates of natural gas efficiency. Energy savings over 20 years averaged 9 percent.[142] Adjusted for the shorter 2009 to 2020 time period, savings would be 5 percent.

In contrast, a more recent study by the Energy Center of Wisconsin for the Governor's Task Force on Energy Efficiency and Renewable Energy found Wisconsin could cost-effectively decrease consumption of electricity by 0.7 percent per year and natural gas by 0.4 percent per year.[143] That is equal to a 3.6 percent reduction over five years for electricity and 1.7 percent for natural gas.

Energy efficiency improvements may be some of the easiest and least costly ways that Wisconsin can reduce global warming emissions, but there are still several hurdles to overcome. Potential users may not know about the technologies or have an accurate way of computing the relative costs and benefits of adopting them. Even when efficiency improvements are plainly justifiable in the long run, consumers may resist adopting technologies that cause an increase in the initial cost of purchasing a building or piece of equipment. In some cases, as with low-income individuals, consumers may not be able to afford the initial investment in energy efficiency, regardless of its long-term benefits.

Wisconsin can and should more aggressively pursue energy efficiency opportunities by increasing funding for Focus on Energy to levels necessary for the state to achieve the efficiency potential identified in the Energy Center of Wisconsin's study. Furthermore, utility-run programs should also be enhanced to increase savings.

## The Importance of Industrial Energy Efficiency

Establishing strong industrial energy efficiency programs is crucial for Wisconsin because the state's industrial sector consumes 23 percent of all energy used in the state, more than the residential, commercial or transportation sectors.[144] Improving industrial energy efficiency will help the state reduce its global warming pollution and save money for industry.

Potential cost savings are great. At five large industrial facilities where the federal Department of Energy invested in energy efficiency upgrades, every dollar spent by the DOE resulted in savings of $47 for the plant.[145] Savings are smaller at small- and medium-sized facilities, but, on average, investments in energy efficiency pay for themselves within 5.2 months.[146]

Within Wisconsin, Focus on Energy has worked with Stora Enso, a paper-making facility (Wisconsin's largest manufacturing sector), to implement efficiency measures such as updating drying procedures and installing compact fluorescent light bulbs.[147] As a result, Stora Enso has lowered its annual energy consumption by 22 million kilowatt-hours (kWh) and 3.6 million therms of natural gas, in turn cutting its annual energy costs by $3.5 million.[148]

## Renewable Energy in Wisconsin's Industries

Since 1953, Wisconsin has led the nation in paper manufacturing, an industry with heavy environmental impacts.[149] A report released by the Environmental Paper Network in 2007 contends that papermaking is the fourth-largest contributor to greenhouse gas emissions among U.S. manufacturers.[150]

One Wisconsin paper mill has recently taken steps that should reduce its global warming pollution. Flambeau River Papers, which took over the Smart Papers mill in Park Falls after that plant shut down due to rising energy costs, has been developing alternative fuel systems that are reducing expenses and reducing environmental impacts of the plant.[151] As a result, Flambeau River Papers has increased its consumption of biomass and reduced daily coal consumption on one boiler from 55 tons to 10 tons, and plans to phase out coal in the next three months. These environmentally friendly strategies have not only saved the mill money on energy costs and reduced its global warming emissions, but they have also helped them attract more attention at trade shows.[152]

Other industries in Wisconsin should follow Flambeau River's example by phasing out coal in favor of cleaner, safer sources of power. While improving energy efficiency is an important step for industries to make, dividends can be achieved environmentally and economically through a shift to renewable fuels as well.

If Wisconsin were to improve its energy efficiency programs, it would reduce electricity use by 4 percent and natural gas slightly compared to savings from current programs, resulting in a 2.7 $MMTCO_2$ reduction in global warming emissions in 2020.

### Strategy #10: Expand Use of Combined Heat and Power

**Potential Savings**
**If policy is enacted alone:**
**0.9 $MMTCO_2$ by 2010;**
**1.6 $MMTCO_2$ by 2020.**

**If policy is enacted with others in this report*:**
**0.9 $MMTCO_2$ by 2010;**
**4.4 $MMTCO_2$ by 2020.**

* See footnote on p. 34 for explanation of different savings figures.

Wisconsin 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 is 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.[153]

Wisconsin could reduce energy waste by promoting the use of combined heat and power (CHP, or "cogeneration") 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.[154]

Various forms of CHP are already in use in Wisconsin, accounting for 1,278 megawatts of generation capacity, roughly the equivalent of 9 percent of Wisconsin's generating capacity.[155] However, a major expansion of CHP capacity is possible. Wisconsin has the technical potential to capture a total of 2,400 megawatts of CHP capacity.[156]

To achieve this potential, Wisconsin could offer technical and financial assistance to facilities by assessing their potential for using CHP and helping to oversee the installation process. Wisconsin can also promote the spread of CHP by educating utilities to the benefits of cogeneration and restructuring incentives to make CHP more cost-effective for utilities.[157]

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.

## Electric Sector Strategies

11. Expand the renewable electricity standard.
12. Limit pollution from coal-fired power plants.

In addition to efforts to conserve electricity, Wisconsin can also reduce carbon dioxide emissions from electricity use by making electricity generation in Wisconsin cleaner—specifically by encouraging a shift away from carbon-intensive fuels such as coal and toward renewable energy sources such as solar and wind. Wisconsin has already taken a large first step toward this goal by encouraging the development of renewable energy sources. At the same time, the state must adopt policies to reduce carbon dioxide emissions from fossil fuel generators.

Expanding the use of renewable sources of energy in the state can help move the state toward a cleaner, more resilient energy system with less impact on the climate. However, the state's carbon dioxide emissions still could rise if large projected expansions in coal-fired electricity generation over the next two decades actually occur. Wisconsin should stop any expansion in coal-fired generation and ensure that the state does not import equally carbon-intensive energy instead.

### Strategy #11: Expand the Renewable Electricity Standard

**Potential Savings**
**If policy is enacted alone:**
**0.8 MMTCO$_2$ by 2010;**
**5.7 MMTCO$_2$ by 2020.**

**If policy is enacted with others in this report*:**
**0.8 MMTCO$_2$ by 2010;**
**8.1 MMTCO$_2$ by 2020.**

* See footnote on p. 34 for explanation of different savings figures.

As discussed earlier, Wisconsin already has a renewable electricity standard (RES) in place. Currently, it mandates that all utilities provide 10 percent of their electricity from clean, renewable sources by 2015. While this is an important first step towards reducing global warming pollution, this measure needs to be strengthened in order to provide greater reductions.

## Solar Energy

Solar energy represents one of the best long-term hopes for Wisconsin to slash its consumption of fossil fuels and emissions of carbon dioxide. By supporting the development of solar energy now, Wisconsin can be in a better position to fully reap the benefits in the decades ahead.

Wisconsin has significant solar energy potential. A solar PV system in Wisconsin can produce approximately 80 percent of the energy of the same system located in Florida.[160] If solar panels (with an average area of 300 square feet per system) were installed on 1 million Wisconsin rooftops, they could produce 5,000 GWh per year, more than 20 percent of the electricity used in Wisconsin homes in 2006.[161]

Solar energy is currently a small player in the generation of electricity in Wisconsin and around the country. However, solar photovoltaics (PV), concentrating solar systems, and solar thermal technologies have the potential to make a major contribution to a clean energy future. Solar PV costs have gone down by 75 percent over the past 20 years.[162] By encouraging the development of solar manufacturing and installation capacity, Wisconsin can help position solar power to make a major contribution to the state's electricity system.

**Solar Photovoltaics**

Solar photovoltaic cells convert light from the sun directly into electricity. The installation of photovoltaics on a rooftop, however, can be expensive; therefore, Wisconsin should establish a structure of financial incentives to help consumers with some of these costs. Other states, such as California, have already taken steps such as these to integrate PV into their residential infrastructure, accruing environmental as well as economic benefits.

Wisconsin should require that new homes be "solar ready" and that builders offer new homebuyers the option of incorporating solar PV. Thousands of new single-family homes are built in Wisconsin each year. Incorporating solar PV systems into homes during construction is one of the most cost-effective and efficient ways to build the state's solar market because it is significantly cheaper than adding systems on existing homes. Policies targeted specifically at new homes—such as requirements to install solar on an increasing percentage of new homes or simply to make systems readily available to homebuyers—can develop one of the most cost-effective parts of the residential PV market.

At a minimum, Wisconsin should set a target for 20 percent of electricity sold in the state to come from renewable sources by 2020. This would allow Wisconsin to achieve additional global warming pollution savings of 5.7 $MMTCO_2$ and consume 14 million MWh from renewable sources. Achieving this level of renewable energy production is entirely feasible and indeed necessary to avoid the worst impacts of global warming.

Wisconsin's wind energy potential is estimated to be as high as 53 million megawatt-hours (MWh) annually, enough to meet 75 percent of Wisconsin's existing electricity demand.[158] By capturing more of this wind energy potential, the state would make great strides towards a new energy future.

Additionally, Wisconsin has enormous potential in biomass fuel, ranging from corn to manure. Wisconsin has almost

Homes equipped with solar panels reduce energy bills for homeowners, potentially increasing the amount of income they can afford to spend on a mortgage and boosting their satisfaction with their home. More than half of homeowners who recently purchased a solar home did so to save money and more than 80 percent believe the solar panels will be a positive feature when reselling the home.[163]

Wisconsin should establish a goal of installing solar panels on the roofs of 20 percent of new homes built by 2020 and generating 2 percent of the state's total electricity consumption from solar power. Achieving this goal would not only reduce carbon dioxide emissions, but would also enhance the stability of the state's electric system and create economies of scale that will make solar power a cost-effective alternative for Wisconsin homeowners and businesses within the next two decades. The state would then be poised for a dramatic increase in solar installations in subsequent years, precisely when the state will be seeking deep reductions in its global warming emissions in keeping with the long-term goal of preventing further harm to the climate.

**Solar Thermal Energy and Passive Solar**

Using the sun's rays to generate electricity is just one of many ways to use solar energy to reduce the use of fossil fuels and cut global warming emissions.

Solar hot water systems use solar energy to produce hot water for bathing, laundry and other household uses. A solar water heating system can provide more than half of the hot water needs of a Wisconsin residence.[164]

Solar energy can even be used to heat and cool buildings. Passive solar building design uses appropriate building layouts and the judicious use of glass to light and heat interior building spaces.

Many solar hot water systems and passive solar designs have the advantage of being less expensive to implement (and often more cost-effective) than solar PV systems. Wisconsin should establish a financial incentive for up to 20 percent of the cost of installing a solar water heating system as a step toward promoting solar energy. Incentives or standards for energy-efficient buildings could encourage the development of buildings that use passive solar heat and light.

Solar hot water systems and passive solar energy have great potential to reduce fossil fuel consumption in Wisconsin.

15 million tons of available biomass, which could be used to replace 15 million tons of coal, equivalent to 56 percent of Wisconsin's total coal use.[159]

In sum, filling a 20 percent by 2020 renewable electricity standard for Wisconsin is possible—even without factoring in future technology improvements that could make solar panels more effective at turning the sun's energy into electricity and wind power feasible at lower wind speeds. Adding other types of renewable energy to the mix—such as landfill gas and solar photovoltaic panels—makes the goal of generating 20 percent of all electricity consumed in Wisconsin by 2020 from clean sources even more reasonable. Renewable energy imported from other states can also be used to satisfy requirements of the RES.

As Wisconsin considers expanding its RES, it should adhere to a commitment

to truly clean, truly renewable technologies. Polluting and environmentally damaging technologies, along with those that rely upon non-renewable resources, should continue to be ineligible for credit under the RES.

**Strategy #12:**
**Limit Emissions from Coal-Fired Power Plants**

**Potential Savings**
**If policy is enacted alone:**
**1.5 MMTCO$_2$ by 2010; 4.8 MMTCO$_2$ by 2020.**

**If policy is enacted with others in this report:**
**Same as if policy is enacted alone. Emission savings are allocated among other policies.**

One of the most important things Wisconsin can do to combat global warming in the next two decades is to address high emissions from electricity generation.

Coal-fired electricity generation produces more carbon dioxide per unit of energy produced than virtually any other option for generating power. In 2005, Wisconsin's coal-fired power plants produced 1.17 tons of carbon dioxide for every megawatt-hour of power produced, compared to 0.92 tons for every megawatt-hour of power produced from natural gas and zero emissions from wind and solar power.[165]

Wisconsin faces two challenges regarding coal-fired generation: high emissions from existing plants and a potentially large increase in emissions if more plants are built.

In Wisconsin, power companies are building or are planning to build a number of new coal-fired power plants. Conventional coal-fired plants are under construction near Milwaukee and Wausau and more have been proposed.[166] A large increase in coal-fired generation in Wisconsin could overwhelm other state efforts to reduce global warming pollution.

To address this dual challenge, Wisconsin should avoid the construction of any new coal-fired power plants and reduce emissions from existing plants by creating a cap on carbon emissions from the electric sector.

### *Establish a Cap on Carbon Dioxide Emissions from Power Plants*

Wisconsin could impose a cap on carbon dioxide emissions from power plants. To comply, power generators would need to improve efficiency, switch to cleaner fuels, reduce generation, or, if they were allowed to trade emission permits, buy pollution allowances from other generators who had reduced their pollution below the required level.

Wisconsin could impose such a cap on its own or as part of a regional effort. A regional cap and trade program would likely produce better results, as it reduces incentives to merely shift power generation out of Wisconsin and into neighboring states.

One example of a regional effort comes from the northeastern U.S., where 10 states recently agreed to create such a program, called the Regional Greenhouse Gas Initiative (RGGI). The initiative calls for emissions from the region's power producers to stabilize at 2009 levels until 2015 and then to be cut by 10 percent below that level by 2019.[167]

The RGGI agreement sets a cap on power plant carbon dioxide emissions for each state. Power plants must hold an "allowance" (or permit) for every ton of carbon dioxide they emit to the atmosphere. States may choose whether to auction off the allowances or give up to 75 percent of them to power generators for free. States that choose to auction

the allowances may then use the funds to promote energy-efficiency improvements and non-carbon emitting forms of power, such as renewables. Any power plant owner that wishes to increase emissions must buy additional allowances from the owners of other power plants that have extra allowances to sell. In theory, this cap and trade system will lead to reductions in carbon dioxide emission at the lowest aggregate economic cost, and the greatest net benefit.

### *Reduce Growth in Electricity Consumption and Production*

Improving the energy efficiency of Wisconsin's economy and expanding clean distributed generation will reduce dependence on power from large, centralized power plants. Many of the policy recommendations in this report will move Wisconsin in this direction, but more remains to be done. As discussed previously, greater investments in energy efficiency could reduce electricity consumption by nearly 4 percent in just 5 years.[168] There are a number of policies available to Wisconsin to capture more of this energy efficiency potential and reduce demand for power from coal-fired power plants.

One way to expand investment in cost-effective energy efficiency is to ensure that efficiency is considered as an alternative to new power plants in the utility regulatory process, and that it is treated fairly. Saving energy through improved efficiency generally costs less than building and operating new power plants, and it certainly costs less if the economic threat of global warming is considered. Utilities should be required to develop resource plans that include the consideration of energy efficiency, renewable energy and other cleaner sources alongside fossil fuel-fired power plants in serving future power demand. This would result in energy efficiency taking on a larger role in Wisconsin's energy supply system and would reduce demand for new power plants.

However, emissions from Wisconsin's power sector depend on more than just what happens inside the state's borders. Wisconsin is currently a net importer of electricity in the region, so regional measures to improve energy efficiency and reduce demand for power across the Midwest could result in ancillary energy cost reductions for the state.[169]

### *Consider the True Cost of Coal-Fired Power Plants*

Coal-fired power plants currently have a series of economic advantages over cleaner sources of energy. Coal-fired power plants are not forced to account or pay for the many environmental and social costs they impose—costs ranging from the public health damage caused by air pollution and unregulated mercury emissions to the use of increasingly scarce water for plant operations. In addition, many older coal-fired power plants are exempt from modern clean air standards, and their carbon dioxide emissions are significant contributors to global warming and the extreme weather events, economic uncertainty and ecological disruption that will result. Excluding these costs makes coal-fired power production in Wisconsin look artificially cheap.

Considering the true cost of coal-fired power plants in utility regulatory proceedings would tend to give a leg up to lower-carbon sources of electricity—such as natural gas and renewables. It could provide an incentive to replace existing, inefficient power stations with cleaner, more efficient technologies—possibly including technologies to capture and store carbon dioxide. (See "Gasified Coal and Global Warming.")

The California Public Utilities Commission requires utilities to include the

## Gasified Coal and Global Warming

Gasified coal (often misleadingly called "clean coal") is being promoted as an environmentally responsible way to use coal to generate electricity. Gasified coal technologies, such as integrated gasification combined cycle (IGCC) coal-fired power plants, have important advantages over conventional coal-fired power plants: they are significantly more efficient and have lower emissions of conventional pollutants.[172] In addition, IGCC technology allows for the capture of carbon dioxide, which some believe can be stored in large quantities underground—theoretically allowing for the production of low- or zero-carbon power from coal.

However, coal gasification is far more expensive than cleaner and more sustainable ways of addressing our nation's energy-related and environmental problems. Coal gasification with carbon storage is more than twice as expensive as typical energy efficiency measures and more than 50 percent more costly than the best wind power projects.[173] Even without carbon storage, coal gasification would cost roughly twice as much as energy efficiency and could at best compete with an average wind farm.[174]

Moreover, carbon capture and storage—on the scale at which it must be implemented to fight global warming—is an immature technology with serious questions about its future viability. Carbon dioxide has been injected into the ground for some time to enhance oil recovery. However, the storage of captured carbon dioxide from utility operations, or from the use of coal gasification to create hydrogen fuel for automobiles, would require a vast expansion of carbon transportation infrastructure and storage. For example, storing all U.S. power plant coal emissions would require enough infrastructure to liquefy and store roughly 2 billion metric tons of carbon dioxide *annually*.[175]

Storing any quantity of carbon dioxide presents problems. As with nuclear wastes, carbon dioxide stored in geological formations must be guaranteed to remain underground for hundreds or thousands of years to prevent re-release to the atmosphere and to prevent accidental, large-scale releases of carbon dioxide, which can be fatal to humans and wildlife. Ocean storage, which has been considered a possible option for carbon management, appears less attractive given research tying increasing ocean carbon dioxide levels with damage to ocean ecosystems.[176]

Provided that the technological hurdles can be overcome, IGCC will likely only become a key player in the energy mix if policies are in place to make it economically competitive with conventional coal technology. A carbon cap that places a market price on carbon dioxide emissions from power plants could provide an incentive for cleaner technologies such as IGCC to develop. Even then, however, IGCC would only deliver global warming benefits if it were used as a replacement for the state's existing fleet of dirty and inefficient coal-fired power plants, not as an addition to them.

cost of controlling or mitigating global warming emissions into their estimates of fuel costs from different sources. Utilities filing plans in California must budget $5 per ton of carbon dioxide in the near term, $13.40 per ton beginning in 2008 and $17.50 by 2013.[170] Another way to ensure that the global warming-related costs of coal-fired power plants are included in the cost of electricity is to adopt a carbon "cap and trade" system in Wisconsin (see previous section).

### *Stop the Expansion of Coal-Fired Generation*

Wisconsin should begin to address emissions from the electricity sector with a moratorium on construction of new coal-fired power plants (Idaho has adopted such a ban for two years, providing time to establish a long-term energy plan).[171] This will help the state avoid short-term power plant construction decisions that would undermine the state's long-term energy goals.

In any case, Wisconsin must plan now for meeting its future energy needs with sources other than coal burned in conventional coal-fired power plants.

## Other Strategies to Reduce Global Warming Pollution

**Strategy #13:**
**Government Lead by Example**

**Potential Savings**
**If policy is enacted alone:**
**1.7 MMTCO$_2$ by 2010;**
**0.5 MMTCO$_2$ by 2020.**

**If policy is enacted with others in this report*:**
**1.7 MMTCO$_2$ by 2010;**
**2.9 MMTCO$_2$ by 2020.**

* See footnote on p. 34 for explanation of different savings figures.

State governments can adopt strong energy efficiency and renewable energy standards for itself to set an example for private businesses and residents. As part of Wisconsin's Energy Efficiency and Renewables Act, passed in 2006, state facility operators must ensure that efficiency standards for heating, cooling and lighting equipment meet or exceed the relevant federal standards.[177]

This government "lead by example" practice was made even stronger by a subsequent executive order from Governor Doyle mandating that the Department of Administration set energy efficiency goals for state facilities, office buildings or complexes, and campuses for fiscal years 2007, 2008, and 2009. These goals should move the state toward a target of reducing overall energy use per square foot by 10 percent by 2008 and 20 percent by 2010, based on the fiscal year 2005 state energy baseline adjusted for weather. Additionally, the executive order directs the department to establish programs for energy use analysis of state-owned buildings, and requires new state facilities to be 30 percent more efficient than the commercial building energy code.[178]

The state has made strides improving the fuel efficiency of government fleets as well. Wisconsin recently purchased nearly 2,000 alternative fueled vehicles including E85 cars that can be fueled by 85 percent ethanol fuel, compressed natural gas (CNG) and propane fueled vehicles, as well as four hybrid vehicles as a pilot.[179]

While the government of Wisconsin has done a good job of setting an example in energy efficiency for the rest of the state, more can and should be done. The emission reductions calculated here are from steps the state has already taken and the enhanced effort outlined below.

**1) Obtain Leadership in Environmental and Energy Design (LEED) certification for all new state buildings.**

A number of buildings in the state—including the Department of Natural Resources headquarters in Mead and Green Bay—have achieved LEED certification, suggesting that a stronger requirement is feasible.[180] Wisconsin should also encourage the development of "zero energy" buildings, such as the Aldo Leopold Legacy Center in Baraboo, which pair strong energy efficiency measures with small-scale renewable energy production to dramatically reduce, or even eliminate, fossil fuel consumption.[181]

**2) Reduce government vehicle fossil fuel consumption by 30 percent by 2020.**

Wisconsin should seek to reduce fossil fuel consumption from government sector vehicles. There are a number of ways Wisconsin could achieve a 30 percent reduction in global warming emissions from the state government's fleet within the next 10 years. These include:

- Requiring that state agencies purchase vehicles with the highest fuel economy possible for their intended use. Implementing such a rule, using vehicles commercially available today, would produce a 28 percent average increase in fuel economy.
- Running all diesel vehicles on B20 (a blend of 20 percent biodiesel and 80 percent gasoline), a change that would reduce global warming pollution from those vehicles by approximately 13 percent.
- Developing a more extensive ethanol fueling infrastructure, which would enable the state to operate more of its flexible fuel vehicles on E85 (85 percent ethanol and 15 percent gasoline) rather than on gasoline.
- Creating stronger incentives for the incorporation of hybrid technology and very fuel efficient vehicles.
- Instituting Campus Transport Management programs at the 24 college campuses that do not already feature them.

**3) Purchase 20 percent of state government's electricity from clean renewable sources by 2015.**

Currently very little of the energy used by state government agencies comes from renewable sources.

Enlisting Wisconsin state government as an aggressive purchaser of renewable electricity—purchasing 20 percent renewable energy by 2015—would provide an important incentive for the development of solar, wind, and other forms of renewable power in the state and region. Government purchases of "green" power should be over and above the levels of renewable power required by the state's renewable electricity standard the state adopts and should include the development of distributed renewable resources on state buildings and land, such as rooftop solar systems where appropriate.

**4) Encourage public sector improvements outside of state government.**

Educational institutions (including public K-12 schools, junior colleges, colleges, universities) as well as municipal governments are major consumers of energy. The state should help promote and drive efforts to reduce carbon dioxide emissions from these institutions. This includes encouraging improvements in energy efficiency, increasing the use of renewable energy (either through purchasing green power or installing distributed electricity generation such as photovoltaic solar power), and helping these institutions purchase more efficient vehicles and equipment.

# The Impact of the Strategies

The strategies listed above outline a path that would lead to significant reductions in carbon dioxide emissions in Wisconsin. We estimate that the specific strategies listed above would lead to a 30 percent reduction in carbon dioxide emissions below projected levels by 2020. (See Figure 6 and the inside of the front cover of the report.) These 13 key policies can provide a strong first step in Wisconsin's efforts to reduce global warming pollution. Together, they would return Wisconsin's emissions to 1990 levels by 2020.

## Opportunities for Further Reductions

These are not the only strategies that have the potential to reduce global warming emissions in Wisconsin. Indeed, the strategies listed above leave some major sources of energy-related global warming pollution—including air travel, industrial energy use, and emissions of non-carbon dioxide global warming pollutants—virtually untouched. And the policies do not address non-energy emissions, such as from farming, waste management, mining and land use.

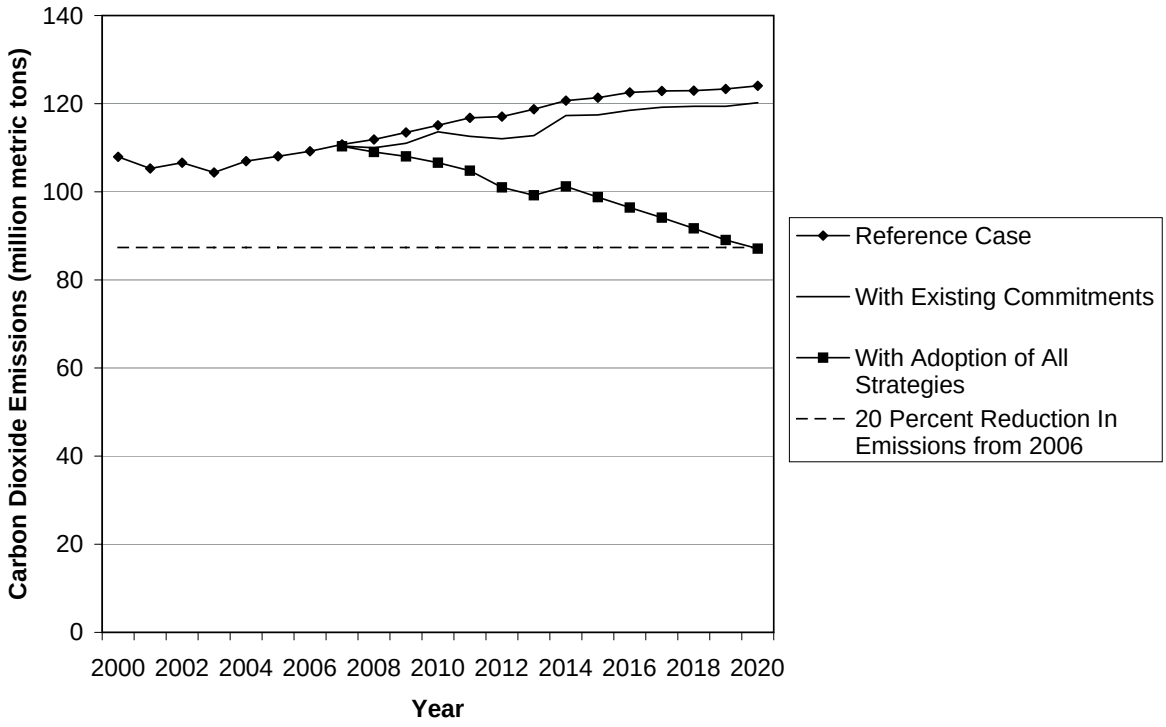
Wisconsin will need to develop effective strategies for stemming the growth of global warming emissions from these portions of the economy. A stringent cap on emissions of global warming pollution can help to drive and motivate these changes.

### 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. However, there are many benefits 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:

**Figure 6. Projected Carbon Dioxide Emissions in Wisconsin with Recommended Strategies**




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. New Jersey has since adopted a similar cap. Wisconsin could adopt a comparable policy and encourage its adoption by neighboring states or at the federal level.

Wisconsin has an important role to play in the broader debate over efforts to reduce global warming emissions. First, Wisconsin—with the policies it has already adopted—is well-positioned to be a regional leader on global warming policy and to communicate the stakes of U.S. policy on global warming emissions to federal officials. Second, Wisconsin can demonstrate policies that are both effective for reducing global warming emissions and also good for the economy. Finally, Wisconsin should set its own, science-based targets for reducing global warming emissions and adopt the public policies necessary to ensure that they are met.

# Methodology and Technical Discussion

## General Assumptions and Limitations

This report makes projections of Wisconsin's future emissions of carbon dioxide and provides estimates the impact on future emissions 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 Wisconsin. Emissions through 2004, and for some fuels in 2005, are based on state-specific EIA estimates of energy consumption in Wisconsin. Emissions for remaining fuels in 2005 and all fuels in 2006 and future years are based on projected rates of growth in energy use for the East North Central region (which includes Wisconsin along with Illinois, Indiana, Michigan and Ohio) adjusted to reflect the higher projected population growth in Wisconsin versus the region as a whole. Specific conditions in Wisconsin 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 emissions of carbon dioxide from energy use and electricity production in Wisconsin. Global warming is also exacerbated by emissions of other gases (such as methane and nitrous oxide) within Wisconsin, by emissions of carbon dioxide resulting from the production of electricity in other states for use in Wisconsin, and by "upstream" emissions resulting from the energy consumed to produce goods and services used by Wisconsin residents.

Thus, this analysis is not a comprehensive view of the cumulative impact of Wisconsin on the global climate, but rather focuses only on the most significant means by which Wisconsin 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 2007 dollars, unless otherwise noted.

## Baseline Emissions Estimates

All estimates are based on Wisconsin's fossil fuel consumption data (in BTU) through 2004 from U.S. Department of Energy, Energy Information Administration (EIA), *State Energy Consumption, Price and Expenditure Estimates*, downloaded from www.eia.doe.gov, 27 March 2007. We included 2005 data for nuclear and renewable energy and some petroleum products, per EIA, *State Energy Consumption, Price and Expenditure Estimates, 2005 Updates by Energy Source*, downloaded from www.eia.doe.gov, 14 September 2007.

In general, we followed the methodology for converting energy use data to carbon dioxide emissions found in EIA, *Documentation for Emissions of Greenhouse Gases in the United States 2004 ("Documentation 2004")*, December 2006. The following section describes sources of data used as well as places where we deviated from the methodology described in *Documentation 2004*.

### Adjustments to Energy Consumption Data

#### Ethanol

EIA state energy data for gasoline consumption include ethanol used as a blending component. EIA assumes that ethanol produces no net emissions of carbon dioxide. To adjust for this, we calculated the percentage of ethanol used in motor gasoline by volume in 1990-2004 using EIA state energy data. We then reduced consumption of motor gasoline (in BTU) by this percentage.

#### Adjustments Not Made

*Documentation 2004* calls for several small adjustments to be made with regard to natural gas emissions to avoid double-counting of emissions related to injections of still gas, synthetic gas, and biogas (landfill gas) into natural gas pipelines. The volume of these gases injected into pipelines is very small (EIA estimates that these adjustments are likely to account for, at most, a 0.1 percent difference in national emissions). For the sake of simplicity and to avoid the need to split out emission reductions into various sectors of the economy, we assumed that these reductions would have a minimal impact on total emissions and did not make them.

In addition, *Documentation 2004*, consistent with international norms, treats international bunker fuels as a separate category of emissions that are not attributed to the United States. A Wisconsin-specific estimate of bunker fuel use for international aviation or shipping was unavailable. As a result, we opted not to adjust for bunker fuel use. This may result in somewhat higher transportation sector emissions compared with other analyses.

### Adjustments for Non-Fuel Use

Many fossil energy sources are also used for non-fuel purposes (for example, petrochemicals used in the manufacture of plastics or natural gas used in the production of fertilizer). Energy sources used for non-fuel purposes emit carbon dioxide at different rates than those used as fuels. To account for this, we calculated or

obtained the percentage of various energy products used for non-fuel purposes and accounted for the percentage of carbon that is "sequestered" (not emitted) from those uses.

State-specific information on the quantity of energy products used for non-fuel purposes is not available. Thus, we used national-level data from *Documentation 2004* (with some exceptions, noted below) to estimate the percentage of various fossil energy products used for non-fuel purposes from 2001-2004. For 1990 and 2000, we used non-fuel percentage estimates from EIA, *Documentation for Emissions of Greenhouse Gases in the United States 2001*, *("Documentation 2001")*, 20 December 2002.

Exceptions to this are as follows:

- For non-fuel use of distillate and residual fuel oil and liquefied petroleum gases from 2001-2004, we determined that the data on non-fuel energy consumption provided in *Documentation 2004* were likely in error. As a result, we used values from *Documentation 2003* instead.
- We assumed (per *Documentation 2004*) that non-fuel use of natural gas for the production of nitrogenous fertilizers was a non-sequestering use (e.g. that all of the carbon in the natural gas is emitted). For the sake of simplicity, we treated use of natural gas in fertilizer production in the same manner as we did use of natural gas for energy purposes. Because a breakout for other non-fuel uses of natural gas was not available in *Documentation 2001*, we calculated this figure for 1990 and 2000 based on data from *Documentation 2000*.

For all years, we used estimates of the percentage of carbon sequestered for non-fuel uses of energy from *Documentation 2004*.

In estimating carbon dioxide emissions from non-fuel uses of energy, we treated differences in the carbon coefficients of fuel and non-fuel uses of liquefied petroleum gases as trivial and used the coefficient for fuel uses for all consumption of LPG.

## Carbon Coefficients and Emission Factors

Carbon coefficients for various fuels for 2001-2004 were based on values in *Documentation 2004*. Coefficients for 1990 and 2000 were based on U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, *1990-2001*, April 2003. For "other petroleum products," carbon coefficients for 2005 from *Documentation 2004* were used for all years.

Weighted emission factors were then calculated for fuel and non-fuel uses of various energy sources. The weighted emission factor for fuel uses was obtained by multiplying the carbon coefficient by the percentage of the source consumed for fuel uses, and then multiplying the product by a combustion factor. It was assumed that 99 percent of solid and liquid fuels were combusted and 99.5 percent of gaseous fuels combusted, per *Documentation 2004*. For non-fuel uses, the weighted emission factor was calculated by multiplying the carbon coefficient by the percentage of energy used for non-fuel purposes, and then multiplying the product by the percentage of carbon not sequestered. The weighted emission factors for fuel and non-fuel uses were then summed to arrive at an emission factor that, when applied to EIA's estimates of state energy consumption, yielded estimates of carbon dioxide emissions by fuel and by economic sector.

We did not incorporate emissions from natural gas flaring or emissions

from geothermal energy sources in this analysis. Combustion of wood, biomass and waste was excluded from the analysis per EIA, *Documentation 2004*. 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 Wisconsin are generally based on applying the East North Central region year-to-year projected growth rate for each fuel in each sector from EIA's *Annual Energy Outlook 2007 (AEO 2007)* to the Wisconsin baseline emissions estimate for 2004 (or 2005 when available). Because Wisconsin's population (and presumably its economic activity) is projected to increase at a faster rate than the East North Central region as a whole, we multiplied the year-by-year growth rate from *AEO 2007* by the ratio between the projected population growth rate in Wisconsin (from the U.S. Census Bureau), and the regional population growth rate.

EIA assumes that new facilities will be constructed to turn coal into liquid fuel, beginning in 2011. The diesel fuel produced by the plants is included in EIA's distillate fuel data. The remaining power was assigned a carbon coefficient equal to steam coal, per T. Crawford Honeycutt, Energy Information Administration, personal communication, 30 March 2007.

We further assumed that not all the major public policy step described in the "Commitments Already Made" section are factored into the estimates of energy use in *AEO 2007*. EIA states that *AEO 2007* reflects all legislation and policies adopted as of October 31, 2006. Though Wisconsin's renewable electricity standard was adopted well before that deadline, *AEO 2007* does not include emission savings from the standard.

## Carbon Dioxide Reductions from Electricity Savings and Renewable Energy Use

Wisconsin generates less electricity than it consumes and thus must import approximately 18 percent of its electricity, though it also may sell some of its power to other states at times. In this analysis we assume that any measures that reduce fossil fuel generation or increase renewable generation apply only to the power that is produced in Wisconsin. Measures that reduce electricity consumption in Wisconsin or that expand renewable electricity generation were assumed to reduce the generation of electricity in Wisconsin by a proportional amount. That is to say, the proportion of electricity Wisconsin is projected to import from other states was held constant in this analysis.

Carbon dioxide emission reductions resulting from reduced demand for fossil fuel powered generation in Wisconsin were calculated as follows:

Net electricity generation from each type of fuel was estimated by multiplying consumption of each fuel for electricity generation in Wisconsin (from the EIA State Energy Data database) by the average heat rate of generators using that fuel for the Mid-America Interconnected Network (of which Wisconsin is a part). Heat rates for fossil fuel-fired power plants were calculated by divid-

ing the amount of each fuel consumed in the MAIN region by the net generation from that fuel (with both figures coming from the supplementary tables to EIA's *AEO 2007*). For 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*, Appendix B, downloaded from www.eia.doe.gov/emeu/states/_seds_tech_notes.html, 3 April 2007.

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.

Before 2014, reduced electricity demand or increased renewable production was assumed to reduce the need for new natural gas plants, thus holding natural gas generation constant at 2007 levels. Additional reductions were assumed to offset generation from coal. From 2014 to 2020, generation from nuclear power was offset first, until one-third of projected nuclear power generation was offset. One-third of Wisconsin's generating capacity is equal to production at Kewaunee, one of Wisconsin's three nuclear plants. Kewaunee is scheduled to be retired at the end of 2013. Both Point Beach reactors are scheduled to continue operating. Additional reductions were assumed to offset generation from coal.

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.

# Emission Reductions from the Strategies

## Commitments Already Made

### Renewable Electricity Standard

EIA states in *Assumptions to the AEO 2007* that it does not attempt to include state requirements for renewable electricity generation in its data and thus Wisconsin's existing renewable energy standard (RES) is not reflected in the baseline. We calculated savings from Wisconsin's current RES assuming that current renewable generation equals 2.2 percent of total consumption and that the percentage increases linearly from 2007 to 2015, when it reaches 10 percent of consumption. Carbon dioxide savings from the RES were calculated as described above in "Carbon Dioxide Reductions from Electricity Savings and Renewable Energy Use."

### Energy Efficiency

The energy efficiency benefits to date of Wisconsin's energy efficiency initiative, Focus on Energy, were calculated to be 1,031 GWh cumulatively from 2001-2006 from the State of Wisconsin Department of Administration Division of Energy's *Focus on Energy Public Benefits Evaluation*, September 2006. Future savings from energy efficiency programs were projected assuming funding remains steady for Focus on Energy and that the program is able to obtain consistent savings in coming years.

## Additional Strategies

### 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 (CARB), *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 Wisconsin 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 2005 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. (Wisconsin-specific data on VMT splits are unavailable but the state has a slightly lower ratio of registered cars to trucks than the national average. This should make our analysis of the program's 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 Wisconsin 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 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 2005 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 45 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 2007*. 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 2007*.

Emissions from vehicles complying with the standards until 2015 (model year 2016) 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*. 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.[182] To account for this effect, carbon dioxide reductions in each of the scenarios were discounted by 5 percent. This estimate is moderate: 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.[183]
- **Mix shifting** – We assumed that neither of the policies under study would result in changes in the class of vehicles purchased by Wisconsin 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.

### 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:

$$M = M_0 - (e \bullet (p/t_0))$$

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 31 August 2006. Per-mile cost of insurance ($p$) is based on 80 percent of the average collision and liability insurance expenditure in Wisconsin in 2005 from Insurance Information Institute, *Facts and Statistics: Average Expenditures for Auto Insurance by State, 1999-2005*, downloaded from www.iii.org/media/facts/statsbyissue/auto, 25 September 2007. The value $t_0$ includes per-mile expenditures for gasoline, maintenance and tires from American Automobile Association, *Your Driving Costs 2007*, downloaded from www.aaaexchange.com/Assets/Files/20073261133460.YourDrivingCosts2007.pdf, 25 September 2007. 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 Wisconsin is based on the following assumptions:

1. The program would include all Wisconsin 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 5 percent in 2008, with the goal increasing by 4 percent each year until a 40 percent reduction in commuting miles traveled is achieved in 2017.
3. Compliance with the program is 75 percent.

Commutes were estimated to account for approximately 27 percent of vehicle travel in Wisconsin 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 62 percent of all

Wisconsin workers based on U.S. Census Bureau, *Statistics of U.S. Businesses: 2004: Wisconsin—All Industries by Employment Size of Enterprise*, downloaded from www.census.gov/epcd/susb/2004/wi/WI--.HTM, 25 September 2007.

### 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 Wisconsin is stabilized beginning in 2009. Future VMT growth increases are held to the rate of population growth projected for Wisconsin in U.S. Census Bureau, *Interim State Population Projections 2005*, 24 September 2007, 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 2007*. The ratio of these two VMT growth rates was then applied to the year-over-year growth rate in transportation gasoline consumption from *AEO 2007* 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.

### Low-Carbon Fuel Standard

Estimates of emission reductions from the adoption of a low-carbon fuel standard are based on an assumption that the state will require a 1 percent reduction in the carbon intensity of motor gasoline and diesel in the transportation sector beginning in 2011. The standard will increase by 1 percent per year until 2020, when the standard will require a 10 percent decrease in carbon emissions from transportation-related gasoline and diesel consumption.

## Residential, Commercial and Industrial Sector Strategies

### Building Energy Codes

The projected impact of building energy codes is based on the assumption that building code improvements will affect the energy efficiency of new buildings only. 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 East North Central Region by determining the approximate median age of commercial floorspace in the East North Central 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, we assumed a 30 percent reduction in oil and natural gas consumption in new homes, from 2010 to 2012. Current Energy Star standards are 15 percent better than the 2004 International Residential Code (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) and Wisconsin's current residential code is assumed to be 15 percent weaker than that. Beginning in 2013, we assume further reductions in energy consumption of 5 percent every three years, assuming that codes will be updated regularly.

For commercial codes, we assume a 25 percent reduction in consumption of all fuels in new commercial buildings, beginning in 2010 from the adoption of more stringent codes. This goal is fully achievable: the American Institute of Architects has established a goal of reducing fossil fuel use in new buildings by 50 percent by 2010 (American Institute of Architects, *Architecture 2030: The 2030 Challenge*, January 2006).

### Appliance Efficiency Standards

Estimates of potential energy savings from appliance efficiency standards were based on state-specific estimates for Wisconsin 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. (See Table 1.) 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 Energy Efficiency Programs

Projections of benefits from expanded energy efficiency programs were based on the savings potential identified in Energy Center of Wisconsin's report for the Governor's Taskforce on Energy Efficiency and Renewables, *Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006-2015*, November 2005, minus savings from existing electricity and natural gas efficiency programs.

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

**Table 1. Energy Savings by Appliance from Stronger Efficiency Standards**

| | Year of Introduction | Lifespan of Product | Savings from One Year of Sales | | Savings in 2020 | |
|---|---|---|---|---|---|---|
| | | Years | GWh | Million cubic feet of natural gas | GWh | Million cubic feet of natural gas |
| Bottle-type water dispensers | 2009 | 8 | 0.6 | | 5.0 | |
| Commercial boilers | 2012 | 30 | | 10 | 0.0 | 76.0 |
| Commercial hot food holding cabinets | 2009 | 15 | 0.6 | | 6.6 | |
| Compact audio products | 2009 | 5 | 6.8 | | 34.0 | |
| DVD players | 2009 | 5 | 1 | | 5.0 | |
| Liquid immersed distribution transformers | 2009 | 30 | 12.9 | | 141.9 | |
| Medium voltage dry-type distribution transformers | 2009 | 30 | 0.8 | | 8.8 | |
| Metal halide lamp fixtures | 2009 | 20 | 13.7 | | 150.7 | |
| Pool heaters | 2012 | 15 | | 9 | 0.0 | 159.4 |
| Portable electric spas | 2009 | 10 | 0.2 | | 2.0 | |
| Residential furnaces and boilers | 2012 | 18-25 | 58.4 | 274.3 | 496.0 | 2489.4 |
| Single voltage external AC to DC power supplies | 2009 | 7 | 13.7 | | 95.9 | |
| State-regulated incandescent | 2009 | 0.94 | 116.9 | | 109.9 | |
| Walk-in refrigerators and freezers | 2009 | 12 | 7.4 | | 81.4 | |

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).

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 Carbon Dioxide Reductions from Electricity Savings and Renewable Energy Use," above.

### Expanded Use of Combined Heat and Power

Future commercial and industrial power generation from CHP were estimated based the potential identified in Midwestern CHP Application Center, *BCHP Baseline Analysis for the Wisconsin Market*, September 2002. We assumed that the additional 1,100 MW of CHP potential described in the above study would be phased in linearly between 2009 and 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.

## Electric-Sector Strategies

### Expanded Renewable Electricity Standard

The increased renewable electricity standard (RES) is assumed to increase from current levels linearly from 2009 to 2020, ultimately reaching a full 20 percent requirement in 2020.

### Reduce Pollution from Coal-Fired Power Plants

We assume that generation from coal-fired power plants is stabilized beginning in 2009.

## Other Strategies

### Government Lead By Example

Baseline estimates of public sector energy consumption in Wisconsin 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, East North Central regional figures were used. Fuel oil data was only available for the Midwest region as a whole. The resulting percentage was then applied to Wisconsin commercial energy consumption in the reference case to arrive at an estimate of government building energy use in Wisconsin. Fuels not included in *CBECS* were assumed not to be used in Wisconsin government buildings.
- **Government vehicles** – Government vehicle energy use was estimated by dividing public sector gasoline consumption with total gasoline consumption in Wisconsin from U.S. Department of Energy, Federal Highway Administration, *Highway Statistics 2005*, March 2007. 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:

- 20 percent reduction in government energy use, beginning in 2007 and phased in over four years until 2010, a policy that the state has already committed to;

- 20 percent of electricity from renewable energy, phased in from 2009 to 2020;
- 30 percent reduction in vehicle fossil fuel consumption by 2020.
- 50 percent reduction in new building energy consumption, assuming that all additional government building energy consumption beyond 2007 takes place in new buildings;

## 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.
- Emission reductions from limiting the growth in coal-fired power plants overlaps with savings accomplished through energy efficiency and increased renewable energy generation. Those savings were counted only once.

# Notes

1. Intergovernmental Panel on Climate Change, *IPCC Fourth Assessment Report, Climate Change 2007: The Physical Science Basis, Summary for Policy Makers,* 5 February 2007.

2. Ibid.

3. R.K. Pachauri and Babu Jallow, Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis*, Powerpoint presentation, 6 February 2007.

4. J. Hansen, et al., National Aeronautics and Space Administration (NASA) Goddard Institute for Space Studies, *GISS Surface Temperature Analysis: Global Temperature Trends: 2005 Summation*, downloaded from data.giss.nasa.gov/gistemp/2005/, 23 May 2006.

5. National Climatic Data Center, *2006 Annual Climate Review, National Summary,* 21 June 2007. Note that though NASA revised its analysis of the hottest years on record in August 2007, the National Climatic Data Center's data has not required such revision.

6. See note 1.

7. Ibid.

8. National Aeronautics and Space Administration, *NASA Examines Arctic Sea Ice Changes Leading to Record Low in 2007* (press release), 1 October 2007.

9. J.T. Overpeck, et al., "Arctic System on Trajectory to New, Seasonally Ice-Free State," *Eos*, 86(34):309-316, August 2005.

10. See note 3.

11. Ibid.

12. See note 1.

13. National Oceanic and Atmospheric Administration, *Subsidence and Sea Level Rise in Louisiana: A Study in Disappearing Land*, 21 July 2003.

14. Intergovernmental Panel on Climate Change, *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability: Summary for Policy Makers*, April 2007.

15. See note 1.

16. Kerry Emanuel, "Increasing Destructiveness of Tropical Cyclones Over the Last 30 Years," *Nature*, 436:686-688, 4 August 2005.

17. P.J. Webster, et al., "Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment," *Science*, 309 (5742):1844-1846, 16 September 2005.

18. National Oceanic and Atmospheric Administration, *Noteworthy Records of the 2005 Atlantic Hurricane Season*, originally published 29 November 2005, updated 13 April 2006.

19. Lee Bergquist and Thomas Content, "A Change in Climate: Global Warming in Wisconsin," *Milwaukee Journal-Sentinel*, 24 March 2007.

20. K.E. Kunkel, K. Andsager and D.R. Easterling, "Long-Term Trends in Heavy Precipitation Events over North America," *Journal of Climate*, 12:2513-2525, 1999, cited in Union of Concerned Scientists and Ecological Society of America, *Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems*, April 2003.

21. World Meteorological Organization, *First WMO Greenhouse Gas Bulletin: Greenhouse Gas Concentrations Reach New Highs in 2004* (press release), 14 March 2006.

22. American Academy for the Advancement of Sciences, *New Research in* Science *Shows Highest $CO_2$ Levels in 650,000 Years* (press release), 28 November 2005.

23. See note 3.

24. Percentage contribution to global warming in this section based on U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States*, Executive Summary, November 2006.

25. See, for example, James Hansen and Larissa Nazarenko, "Soot Climate Forcing via Snow and Ice Albedos," *Proceedings of the National Academy of Sciences*, 101: 423-428, 13 January 2004 for a discussion of the potential impact of black carbon on global warming and the uncertainty in estimating the magnitude of that impact.

26. U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States*, Executive Summary, November 2006.

27. Malte Meinshausen, "What Does a 2˚C Target Mean for Greenhouse Gas Concentrations? A Brief Analysis Based on Multi-Gas Emission Pathways and Several Climate Sensitivity Uncertainty Estimates," in Hans Joachim Schnellnhuber, ed., *Avoiding Dangerous Climate Change*, Cambridge University Press, 2006.

28. Rachel Warren, "Impacts of Global Climate Change at Different Annual Mean Global Temperature Increases," in Hans Joachim Schnellnhuber, ed., *Avoiding Dangerous Climate Change*, Cambridge University Press, 2006.

29. James Hansen, "A Slippery Slope: How Much Global Warming Constitutes 'Dangerous Anthropogenic Interference?'" *Climatic Change*, 68:269-279, 2005.

30. Rachel Warren, "Impacts of Global Climate Change at Different Annual Mean Global Temperature Increases," in Hans Joachim Schnellnhuber, ed., *Avoiding Dangerous Climate Change*, Cambridge University Press, 2006, and Malte Meinshausen, "What Does a 2˚C Target Mean for Greenhouse Gas Concentrations? A Brief Analysis Based on Multi-Gas Emission Pathways and Several Climate Sensitivity Uncertainty Estimates," in Hans Joachim Schnellnhuber, ed., *Avoiding Dangerous Climate Change*, Cambridge University Press, 2006.

31. Ibid.

32. Corresponds to scenario A1F1 in Intergovernmental Panel on Climate Change, *IPCC Fourth Assessment Report, Climate Change 2007: The Physical Science Basis, Summary for Policy Makers,* 5 February 2007.

33. See note 1.

34. Wisconsin Academy of Sciences, Arts and Letters, *Waters of Wisconsin: The Future of Our Aquatic Ecosystems and Resources*, 2003.

35. J.H. Christensen, et al., "2007: Regional Climate Projections," in Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis*, 2007. Based on projection for central North America.

36. Union of Concerned Scientists and Ecological Society of America, *Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems*, April 2003.

37. Jeff Alexander, "Data Shows Warming Eventually Will Shrink Great Lakes," *Muskegon Chronicle*, 5 February 2007.

38. Great Lakes Regional Assessment Group, *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change: Great Lakes Overview,* 2000.

39. U.S. Army Corps of Engineers, et al., *Lake Level FAQs*, 7 January 2000.

40. Union of Concerned Scientists and Ecological Society of America, *Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems*, April 2003.

41. See note 38.

42. See note 40.

43. Richard Thomas, "Tourism Industry Deals with Climate Change: Snow Didn't Come in Time," *BusinessNorth.com*, 19 March 2007 and Lee Bergquist and Thomas Content, "A Change in Climate: Global Warming in Wisconsin," *Milwaukee Journal-Sentinel*, 24 March 2007.

44. National Oceanic and Atmospheric Administration, National Climatic Data Center, *NCDC Storm Event Database,* downloaded from www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms, 11 Sep 2007.

45. "Wisconsin Flood Damage," *Lake-County News Sun*, 25 Aug 2007, accessed online at www.suburbanchicagonews.com/newssun/news/527594,5_1_WA25_WISFLOODS_S1.article 11 Sept 2007.

46. Increase in extreme rain events based on Noah S. Diffenbaugh, et al., "Fine Scale Processes Regulate the Response of Extreme Events to Global Climate Change," *Proceedings*

*of the National Academy of Sciences*, 102: 15574-15778, 1 November 2005.

47. Impact on headwaters streams and groundwater from Union of Concerned Scientists and Ecological Society of America, *Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems,* April 2003.

48. Robert M. Scheller and David J. Mladenoff, "A Spatially Interactive Simulation of Climate Change, Harvesting, Wind, and Tree Species Migration and Projected Changes to Forest Composition and Biomass in Northern Wisconsin, USA," *Global Change Biology*, 11:307-321, 2005.

49. Wisconsin Department of Natural Resources, Division of Forestry, *Wisconsin Forest Management Guidelines, Chapter One, Wisconsin's Forests, A Quick Overview*, October 2003.

50. See note 40.

51. American Bird Conservancy, National Wildlife Federation, *Global Warming & Songbirds: Wisconsin*, downloaded from www.abcbirds.org/iba/Wisconsin.htm, 12 April 2007.

52. 46 percent of Wisconsin's land area is covered by forest: Great Lakes Regional Assessment Group, *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change: Great Lakes Overview*, 2000.

53. Center for Technology Transfer, Inc., *Wisconsin's Forest Products Industry Business Climate Status Report 2004*, undated.

54. Davidson-Peterson Associates, *The Economic Impact of Expenditures by Travelers on Wisconsin Calendar Year 2005*, prepared for Wisconsin Department of Tourism, March 2006.

55. N.R. St. Pierre, B. Cobanov and G. Schnitkey, "Economic Losses from Heat Stress by U.S. Livestock Industries," *Journal of Dairy Science*, 86:E52-E77, 2003.

56. Gerald M. Jones and Charles C. Stallings, Virginia Cooperative Extension, *Reducing Heat Stress for Dairy Cattle*, October 1999.

57. Monte R. O'Neal, et al., "Climate Change Impacts on Soil Erosion in Midwest United States with Changes in Crop Management," *Catena*, 61: 165-184, 2005.

58. See Brian Fisher, et al., "Issues Related to Mitigation in the Long-Term Context," *Climate Change 2007: Mitigation of Climate Change, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 2007.

59. European Environment Agency, *Atmospheric Greenhouse Gas Concentrations (CWI013)–Assessment Publiced Oct 2005*, downloaded from themes.eea.europa.eu/IMS/Ispecs/Ispecification20041007131717/Iassessment1116319511425/view_content, 29 June 2007.

60. Intergovernmental Panel on Climate Change, Working Group III, *Climate Change 2007: Mitigation of Climate Change, Summary for Policymakers,* 2007.

61. See "Methodology and Technical Discussion" at the conclusion of this report for details on the methods used to estimate carbon dioxide emissions in Wisconsin.

62. Based on comparison between estimates produced for this report with U.S. Department of Energy, Energy Information Administration, *International Energy Annual 2005*.

63. Wisconsin data based on estimates produced for this report, U.S. data based on U.S. Department of Energy, Energy Information Administration, *International Energy Annual 2005*, 21 July 2006, Table H.1co2.

64. Consumption of motor gasoline in the transportation sector produced approximately 21.7 million metric tons of carbon dioxide in Wisconsin in 2004. Nationally, about 94 percent of the motor gasoline consumed in the transportation sector is used in light-duty cars and trucks (based on data from supplementary tables to U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2006*, February 2006).

Thus, light-duty cars and trucks in Wisconsin produced approximately 20.4 $MMTCO_2$ in 2004, compared to total transportation-sector emissions of 30.8 $MMTCO_2$.

65. Wisconsin Department of Transportation, *Vehicle Miles of Travel (VMT),* downloaded from www.dot.wisconsin.gov/travel/counts/vmt.htm, 24 September 2007.

66. Based on dividing annual vehicle-miles traveled (from Wisconsin Department of Transportation, *Vehicle Miles of Travel (VMT),* downloaded from www.dot.wisconsin.gov/travel/counts/vmt.htm, 24 September 2007) compared to annual population estimates for 1990-2003 from U.S. Census Bureau, Population Division, Interim State Population Projections, 2005.

67. U.S. Census Bureau, *Table CO-EST2001-12-00 - Time Series of Intercensal State Population Estimates: April 1, 1990 to April 1, 2000,* 11 April 2002, and population estimates for 2000-2005 from U.S. Census Bureau, *Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000 to July 1, 2005*, downloaded from www.census.gov/popest/states/NST-ann-est.html, 6 April 2007.

68. Energy Information Administration, *Wisconsin Electricity Profile*, March 2007, downloaded from www.eia.doe.gov/cneaf/electricity/st_profiles/wisconsin.html on 27 September 2007.

69. Energy Information Administration, *Wisconsin State Nuclear Industry*, 23 Aug 2004, downloaded from www.eia.doe.gov/cneaf/nuclear/page/at_a_glance/states/stateswi.html on 27 September 2007.

70. Ibid.

71. Wisconsin Legislative Reference Bureau, *Rethinking the Moratorium on Nuclear Energy*, May 2006.

72. Energy Information Administration, *Kewaunee Power Station: Wisconsin*, downloaded from www.eia.doe.gov/cneaf/nuclear/page/at_a_glance/reactors/kew.html on 27 September 2007.

73. United States Nuclear Regulatory Commission, *Escalated Enforcement Actions Issued to Reactor Licenses – P,* 1 March 2007.

74. Ibid.

75. Iowa Institute of Hydraulic Research, *Water Intake Model Study: Kewaunee Nuclear Power Plant*, March 2001.

76 Dianne D'Arrigo, Nuclear Information Resource Center, personal communication, 1 October 2007.

77. Nuclear Information Resource Center, *The Science and Politics of the Proposed High-Level Radioactive Waste Dump at Yucca Mountain, Nevada, USA*, December 2003.

78. Clean Wisconsin, *Nuclear Waste and Wisconsin: Fact Sheet*, downloaded from www.cleanwisconsin.org/publications/nuclear_waste/NucWaste_FactSheet.pdf on 27 September 2007.

79. Database of State Incentives for Renewables and Efficiency, *Wisconsin Incentives for Renewable Energy: Renewables Portfolio Standard*, downloaded from www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=WI05R&state=WI&CurrentPageID=1&RE=1&EE=1, 6 September 2007.

80. Engrossed Senate Bill 459, 22 Feb 2006, downloaded from www.legis.state.wi.us/2005/data/SB-459eng.pdf, 6 September 2007.

81. State of Wisconsin, *Wisconsin Public Benefits Program Annual Report, July 1, 2005 to June 30, 2006*, available at www.focusonenergy.com.

82. Database of State Incentives for Renewables and Efficiency, *Wisconsin Incentives for Energy Efficiency: Focus on Energy Program*, downloaded from dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=WI15R&state=WI&CurrentPageID=1&RE=0&EE=1, 8 August 2007.

83. State of Wisconsin, *Wisconsin Public Benefits Program Annual Report, July 1, 2005 to June 30, 2006*, available at www.focusonenergy.com.

84. Anne Lupardus, Office of the Governor, *Governor Doyle Signs Senate Bill 459, Bipartisan Energy Efficiency and Renewables Legislation*, 17 March 2006.

85. Consortium on Energy Efficiency, *U.S. Energy-Efficiency Budgets: Figure 1 – 2006 Per Capita Budgets, by State (Electric Programs)*, downloaded from www.cee1.org/ee-pe/budgets-main.php3 on 17 August 2007; Consortium on Energy Efficiency, *U.S. Energy-Efficiency Budgets: Figure 1 – 2006 Per Capita Budgets, by State (Gas Programs)*, downloaded from www.cee1.org/ee-pe/budgets-main.php3 on 17 August 2007.

86. Oregon, Washington, California, Maine, Massachusetts, Vermont, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania and Maryland have adopted the Clean Cars Program.

87. Based on a possible scenario for manufacturer compliance with the program in California in Chuck Shulock, California Air Resources Board, *The California ZEV Program: Implementation Status*, presented at EVS-20, the 20th International Electric Vehicles Symposium and Exposition, November 2003. The flexibility of the ZEV program means that manufacturers have many possible ways to comply with the requirement; this scenario assumes that manufacturers take full advantage of program provisions that allow them to substitute ultra-clean conventional gasoline vehicles and hybrids for "pure" zero-emission vehicles such as fuel-cell vehicles.

88. Associated Press, *Hybrid Car Sales Slowed in 2006: Lower Tax Credits for Toyota Models Seen Influencing Car Buyers*, 26 February 2007.

89. Electric Drive Transportation Association, *Hybrid Sales Figures/Tax Credits for Hybrids*, downloaded from www.electricdrive.org/index.php?tg=articles&topics=7, 10 October 2007.

90. Based on default values from Michael Wang, Argonne National Laboratory, Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) model, version 1.5a, 21 April 2001. Note: All figures for hybrids and conventional vehicles are based on emissions from vehicle operations (i.e. the tailpipe). Because hydrogen fuel-cell vehicles have no tailpipe emissions, fuel-cycle emissions were used. The default energy efficiency of hybrid-electric vehicles in GREET 1.5a is assumed to be 90 percent greater than gasoline-powered vehicles operating on conventional gasoline, while the efficiency of fuel-cell vehicles is assumed to be 2000 percent greater. A draft version of an updated GREET model (GREET 1.6) assumes smaller efficiency improvements from the two technologies.

91. Several studies have estimated ZEV program carbon dioxide reduction benefits in the 1-2 percent range for 2020. Northeast States for Coordinated Air Use Management (NESCAUM), in its October 2003 white paper, Comparing the *Emission Reductions of the LEV II Program to the Tier 2 Program*, estimated reductions of 2.25 percent for three states (New York, Massachusetts and Vermont).

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

93. 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.

94. Meszler Engineering Services, *GHG Emission Standards for Vehicles: An Overview of California's Pavley Requirements*, presentation to Rhode Island GHG Process Stakeholders, 28 April 2005.

95. California Energy Commission, *California State Fuel-Efficient Tire Report: Volume 2*, January 2003.

96. California Assembly Bill No. 844, signed into law 1 October 2003.

97. For a summary of data demonstrating the link between increased vehicle travel and accident risk, see Victoria Transport Policy Institute, *Online TDM Encyclopedia: Pay-As-You-Drive Vehicle Insurance*, downloaded from www.vtpi.org/tdm/tdm79.htm, 30 November 2006.

98. Based on Insurance Information Institute, *Facts and Statistics: The Rising Cost of Auto Insurance,* downloaded from www.iii.org/media/facts/statbyissue/auto, 16 March 2007.

99. The estimate presented here of the percentage decline in vehicle travel that would result from mileage-based insurance premiums is lower than of some similar studies, because of the increase in gasoline prices since those studies were carried out. Because fuel prices have increased to such a large degree over the last several years, insurance costs would make up a smaller share of the overall per-mile cost of operating a vehicle, reducing the impact of mileage-based insurance on travel demand.

100. Victoria Transport Policy Institute, *Online TMD Encyclopedia*, downloaded from www.vtpi.org/tdm/tdm70.htm, 9 May 2005.

101. U.S. Department of Transportation, Federal Highway Administration, *Summary of Travel Trends: National Household Transportation Survey 2001*, December 2004.

102. TDM Encyclopedia*, Campus Transport Management: Trip Reduction Programs on College, University and Research Campuses*, 28 August 2007, downloaded from www.vtpi.org/tdm/tdm5.htm, 12 September 2007.

103. Jeffrey Brown, Daniel Balwin Hess and Donald Shoup, "Fare-Free Public Transit at Universities: An Evaluation," *Journal of Planning Education and Research*, 23: 69-82, 2003.

104. Karen Schmiechen, Department of Transportation, *Southeast Wisconsin's RIDESHARE Program*, downloaded from www.dot.wisconsin.gov/travel/commuter/rs-index.htm on 17 September 2007.

105. State of Wisconsin, Department of Administration, *Vanpool Rideshare Program*, downloaded from www.doa.state.wi.us/section_detail.asp?linkcatid=300&linkid=49&locid=2 on 12 September 2007.

106. RCW 70.94.527.

107. Oregon Department of Environmental Quality, *Employee Commute Options (ECO) Program Frequently Asked Questions*, downloaded from www.deq.state.or.us/nwr/ECO/FAQ.htm, 17 September 2007.

108. Commute Trip Reduction Task Force, *CTR Task Force 2005 Report to the Washington State Legislature*, February 2006.

109. Oregon Department of Environmental Quality, *Oregon State Implementation Plan, Section 4.50, Portland-Vancouver AQMA (Oregon portion) and Salem-Keizer 8-Hour Ozone Maintenance Plan* (discussion draft) 18 April 2006; "1 percent" based on comparison with U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2004*, October 2005.

110. See note 108.

111. U.S.Census Bureau, Population Division, *Interim State Population Projections*, 2005.

112. "14.6 percent" based on the imputed increase in vehicle-miles traveled calculated from reference case assumptions about the growth in motor vehicle gasoline consumption and changes in vehicle fuel economy from U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2007*, February 2007.

113. Based on data from Wisconsin Department of Transportation, *Vehicle Miles of Travel* reports for 2005 and 2006.

114. Milwaukee Connector, *Transit Costs and Funding,* downloaded from www.milwaukeeconnector.com/costsandfinancing.html, 12 September 2007.

115. Transport 2020, *Environmental Impact Statement and New Starts Application*, downloaded from www.transport2020.net, 12 September 2007.

116. *Wisconsin's Comprehensive Planning Legislation*, downloaded from www.doa.state.wi.us/dir/documents/CompPlanStats_0104.pdf on 12 September 2007.

117. California Governor Arnold Schwarzenegger, *Executive Order S-01-07*, 18 January 2007

118. California Office of the Governor, *White Paper: The Role of a Low Carbon Fuel Standard in Reducing Greenhouse Gas Emissions and Protecting Our Economy*, 8 January 2007.

119. Green Car Congress, *Missouri Governor Signs State Renewable Fuels Standard: 10 percent by 2008*, downloaded from www.greencarcongress.com/2006/07/missouri_govern.html, 17 July 2006 and Iowa Renewable Fuels Association, *Provisions of the Iowa Renewable Fuels Standard,* downloaded from www.iowarfa.org/PDF/Iowa_ RFS_Provisions_2ndVERSION.pdf, 25 July 2006.

120. 1.3 billion: Brett Hulsey, Better Environmental Solutions, *Cellulose Prairie: Biomass Fuel Potential in Wisconsin and the Midwest*, April 2007. Ethanol contains 83,333 BTU per gallon and gasoline contains 124,000 BTU per gallon, per Energy Information Administration. Wisconsin consumed 2.6 billion gallons of gasoline in 2006, per Brett Hulsey, Better Environmental Solutions, *Cellulose Prairie: Biomass Fuel Potential in Wisconsin and the Midwest*, April 2007.

121. Brett Hulsey, Better Environmental Solutions, *Cellulose Prairie: Biomass Fuel Potential in Wisconsin and the Midwest*, April 2007.

122. See Nathanael Greene and Yerina Mugica, Natural Resources Defense Council, *Bringing Biofuels to the Pump: An Aggressive Plan for Ending America's Oil Dependence*, July 2005.

123. See Seungdo Kim, Bruce E. Dale, "Life Cycle Assessment of Various Cropping Systems Utilized for Producing Biofuels: Bioethanol and Biodiesel," *Biomass & Energy*, 29: 426-439, 2005.

124. Mark Clayton, "Carbon Cloud Over a Green Fuel," *Christian Science Monitor*, 23 March 2006.

125. See, for example, Mark A. Deluchi, *Lifecycle Analyses of Biofuels* (draft manuscript), May 2006. This analysis finds that biodiesel derived from soy causes a net increase in global warming emissions vis-à-vis conventional diesel, due to large nitrous oxide and carbon dioxide emissions from agricultural practices. Deluchi's results differ significantly from those of several other studies of the global warming impact of biodiesel (see Methodology), in part because of the use of different methods for the calculation of global warming impacts of various greenhouse gases than the approach used by the Intergovernmental Panel on Climate Change (IPCC) and in part due to the assumption that land used for biomass cultivation will replace native vegetation. The variation in estimates of the global warming impacts of biofuels demonstrates the uncertainty surrounding the impact of agricultural practices on global warming. Additional research is needed to resolve these uncertainties and provide policy-makers with guidance for how to ensure that biofuels production delivers the maximum benefit for the environment and the global climate.

126. See, for example, American Council for an Energy-Efficient Economy, *Reforming Dual Fueled Vehicle CAFE Credits*, 4 March 2004.

127. 14 percent from U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2004*, October 2005; increasing by more than 4 percent per year from Stacy C. Davis, Susan W. Diegel, Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 25*, 2006.

128. Stacy C. Davis, Susan W. Diegel, Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 25*, 2006.

129. Therese Langer, American Council for an Energy-Efficient Economy, *Energy Savings Through Increased Fuel Economy for Heavy-Duty Trucks*, prepared for the National Commission on Energy Policy, 11 February 2004.

130. $2.79 per gallon based on U.S. Department of Energy, Energy Information Administration, *Gasoline and Diesel Fuel Update*, 2 April 2007.

131. Building Codes Assistant Project, *Code Status*, downloaded from www.bcap-energy.org/code_status.php, 3 October 2007.

132. Building Codes Assistant Project, *Wisconsin Overview*, downloaded from www.bcap-energy.org/state_status.php?state_ab=WI, 13 September 2007.

133. 2005 Senate Bill 459, 29 November 2005, downloaded from www.bcap-energy.org/newsletter_links/WI_SB-459.pdf on 13 September 2007.

134. Energy Star, *Features of Energy Star Qualified New Homes*, downloaded from www.energystar.gov/index.cfm?c=new_homes.nh_features, 21 September 2007.

135. U.S. Department of Energy and U.S. Environmental Protection Agency, *Energy Star Qualified Market Indices for States*, downloaded from www.energystar.gov/index.cfm?fuseaction=qhmi.showHomesMarketIndex, 13 September 2007.

136. Steven Nadel, Andrew Delaski, et al., American Council for an Energy-Efficient Economy and Appliance Standards Awareness Project, *Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards*, March 2006.

137. See note 136. Implementation date for some appliances was adjusted from 2008 in the ACEEE report to 2009.

138. Anna Monis Shipley and R. Neal Elliott, American Council for an Energy-Efficient Economy, *Ripe for the Picking: Have We Exhausted the Low-Hanging Fruit in the Industrial Sector?*, April 2006.

139. See note 82.

140. State of Wisconsin, *Wisconsin Public Benefits Program Annual Report, July 1, 2005 to June 30, 2006*, downloaded from www.focusonenergy.com on 14 September 2007.

141. Steven Nadel, Anna Shipley and R. Neal Elliott, American Council for an Energy-Efficient Economy, "The Technical, Economic and Achievable Potential for Energy-Efficiency in the US: A Meta-Analysis of Recent Studies," from the proceedings of the *2004 ACEEE Summer Study on Energy Efficiency in Buildings*, 2004.

142. See note 138.

143. Energy Center of Wisconsin for the Governor's Taskforce on Energy Efficiency and Renewables, *Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006-2015,* November 2005.

144. See methodology for how this was calculated.

145. See note 138.

146. Ibid.

147. Tim Wirtz and Robyn Grossman, Hoffman York, *Energy Efficiency Boosts Wisconsin's Largest Manufacturing Sector: Focus on Energy Helps Stora Enso Reduce Annual Energy Costs by $3.5 Million*, 12 April 2005.

148. Ibid.

149. Joel Dresang, "Paper Makers Turn Green, Study Says," *Milwaukee Journal Sentinal*, 2 October 2007.

150. Susan Kinsella, et. al., Environmental Paper Network, *The State of the Paper Industry: Monitoring the Indicators of Environmental Performance*, October 2007.

151. See note 149.

152. Ibid.

153. InterMountain CHP Center, *Information for Policy Makers*, downloaded from www.intermountainchp.org/policymakers/default.htm, 13 September 2007.

154. InterMountain CHP Center, *What Is CHP?*, downloaded from www.intermountainchp.org/whatis.htm, 13 September 2007.

155. Midwestern CHP Application Center, *Combined Heat and Power: Wisconsin*, 27 Feb 2007, downloaded from www.chpcentermw.org/07-09_wi.html, 13 September 2007.

156. Midwestern CHP Application Center, *BCHP Baseline Analysis for the Wisconsin Market*, September 2002.

157. Susanne Brooks, Brent Elswick, and R. Neal Elliott, *Combined Heat and Power: Connecting the Gap between Markets and Utility Interconnection and Tariff Practices,* March 2006, American Council for an Energy-Efficient Economy, downloaded from aceee.org/pubs/ie062.pdf?CFID=54850&CFTOKEN=37474000 on 13 September 2007.

158. 53 million MWh: American Wind Energy Association, *Wind Web Tutorial*, downloaded from www.awea.org/faq/wwt_potential.html, 17 September 2007. 75 percent based on total

electricity consumption as presented in: Energy Information Agency, *Wisconsin Electricity Profile*, March 2007, downloaded from www.eia.doe.gov/cneaf/electricity/st_profiles/wisconsin.html, 17 September 2007.

159. See note 121.

160. Based on a comparison of annual average solar radiation intensities in each state: U.S. Department of Energy, Energy Efficiency and Renewable Energy, *State Energy Alternatives*, 24 October 2006.

161. Wisconsin's solar radiation intensity is about 4,000 watt-hours per square meter per day (U.S. Department of Energy, Energy Efficiency and Renewable Energy, *State Energy Alternatives*, 24 October 2006). We assumed that solar PV technology can achieve a 12 percent light to electricity conversion efficiency and a 20 percent capacity factor.

162. Solarbuzz, *Photovoltaic Industry Statistics: Costs*, downloaded from www.solarbuzz.com, 30 June 2003.

163. Bernadette Del Chiaro, Environment California, *Rave Reviews for Solar Home: A Survey of Homeowners in California*, March 2006.

164. Focus on Energy, *Solar Water Heating Systems Fact Sheet*, downloaded from www.focusonenergy.com/data/common/dmsFiles/W_RS_MKFS_Solar%20water%20heating%20systems%20.pdf on 1 October 2007.

165. Based on data from U.S. Department of Energy, Energy Information Administration, *State Electricity Profiles 2005*, March 2007.

166. Department of Natural Resources and Public Service Commission of Wisconsin, *IGCC: Benefits, Costs and Prospects for Future Use in Wisconsin*, February 2007.

167. Regional Greenhouse Gas Initiative, *Regional Greenhouse Gas Initiative (RGGI) Memorandum of Understanding in Brief*, 20 December 2005.

168. See note 143.

169. Wisconsin imports 18 percent of its electricity, per Wisconsin Department of Administration, Division of Energy, *2006 Wisconsin Energy Statistics*.

170. Steve Weiss, Northwest Energy Coalition, comments to the Oregon Public Utility Commission on LC 39, PacifiCorp's 2005 Electric Least-Cost Plan, 23 May 2005.

171. John Miller, Associated Press, *Sempra to Unload Idaho Coal Plant Project*, 30 March 2006.

172. Jeff Johnson, "Getting to Clean Coal: U.S. Faces a Rocky Path to Clean Up Coal-Fired Electric Power Plants in an Era of Shrinking Federal Dollars and Fewer Regulations," *Chemical and Engineering News* 82: 20-25, 23 February 2004.

173. These cost estimates assume that constant baseload power, such as coal, have the same value as interruptible power such as wind. In reality, a constant resource may be somewhat more valuable. With carbon capture and storage, the Electric Power Research Institute estimates that the levelized cost of electricity in 2003 cents per kWh is 7.98 from pulverized coal, 7.49 from natural gas (assuming gas costs of $5/Mbtu), and 6.53 from IGCC: Stu Dalton, Electric Power Research Institute, *Cost Comparison: IGCC and Advanced Coal*, presented at the Roundtable on Deploying Advanced Clean Coal Plants, Washington D.C., 29 July 2004. In comparison, the U.S. EPA estimates that wind costs between 4 and 6 cents per kWh, with windier areas producing power for lower cost: U.S. Environmental Protection Agency, *Clean Energy-Environment Guide to Action: Policies, Best Practices, and Action Steps for States*, 7 February 2006. Also, typical efficiency programs deliver savings for roughly 3 cents per kWh. For example, efficiency programs in New England in 2002 achieved lifetime savings of 10 billion kilowatt-hours (kWh) of electricity at an average cost of 2.4 cents per kWh, according to the Regulatory Assistance Project: Richard Sedano, Regulatory Assistance Project, *Economic, Environment and Security Effects of Energy Efficiency and Renewable Energy: A Report for EPA and the New England Governors' Conference*, NEEP Policy Conference, 24 May 2005.

174. The Electric Power Research Institute estimates that IGCC without carbon capture

and storage, using a spare gasifier, would generate power at a levelized cost of 4.99 cents per kWh in 2003 terms: Stu Dalton, Electric Power Research Institute, *Cost Comparison: IGCC and Advanced Coal*, Presented at the Roundtable on Deploying Advanced Clean Coal Plants, Washington D.C., 29 July 2004. In comparison, the U.S. EPA estimates that wind costs between 4 and 6 cents per kilowatt-hour, with windier areas producing power for lower cost: U.S. Environmental Protection Agency, *Clean Energy-Environment Guide to Action: Policies, Best Practices, and Action Steps for States*, 7 February 2006. Also, typical efficiency programs deliver savings for roughly 3 cents per kWh. For example, efficiency programs in New England in 2002 achieved lifetime savings of 10 billion kilowatt-hours (kWh) of electricity at an average cost of 2.4 cents per kWh, according to the Regulatory Assistance Project: Richard Sedano, Regulatory Assistance Project, *Economic, Environment and Security Effects of Energy Efficiency and Renewable Energy: A Report for EPA and the New England Governors' Conference*, NEEP Policy Conference, 24 May 2005.

175. U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 2004,* Table 12.7a, 15 August 2005.

176. John Pickrell, "Oceans Found to Absorbed Half of All Man-Made Carbon Dioxide," *National Geographic News,* 15 June 2004.

177. Senate Bill 458, 29 November 2005, downloaded from www.legis.state.wi.us/2005/data/SB-459.pdf.

178. Database of State Incentives for Renewables & Efficiency, *Energy Efficiency and Green Building Standards for State Buildings*, downloaded from www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=WI14R&state=WI&CurrentPageID=1&RE=0&EE=1 on 13 September 2007.

179. Wisconsin Energy Task Force, *Wisconsin State Government Energy Initiatives*, downloaded from www.energytaskforce.wi.gov/docview.asp?docid=33 17 September 2007.

180. *Case Studies*, Wisconsin Green Building Association, 20 July 2007, downloaded from www.wgba.org/artman/publish/cat_index_9.shtml on 13 September 2007.

181. *The Aldo Leopold Foundation*, downloaded from www.aldoleopold.org/index.htm on 13 September 2007.

182. Paul Schimek, "Gasoline and Travel Demand Models Using Time Series and Cross-Section Data from the United States," *Transportation Research Record*, No. 1558 (1996), 83; U.S. General Accounting Office, *Energy Policy Act of 1992: Limited Progress in Acquiring Alternative Fuel Vehicles and Reaching Fuel Goals*, February 2000.

183. 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.