Cars and Global Warming

Policy Options to Reduce Maine's Global Warming Emissions from Cars and Light Trucks

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Table of Contents

Executive Summary

Maine could significantly limit its contribution to global warming over the next two decades by implementing two policies to reduce carbon dioxide emissions from cars and light trucks.

Global warming poses a serious threat to Maine's future. Scientists project that average temperatures in Maine could increase by 2° to 8° F over the next century if no action is taken to reduce emissions of global warming gases – potentially leading to coastal flooding, increased air pollution and heat-related deaths, and a host of other impacts on Maine's environment, public health and economy.

Controlling global warming emissions from the transportation sector—and particularly cars and light trucks—is an essential part of meeting the goals set by the Conference of New England Governors and Eastern Canadian Premiers in 2001 and adopted by the state of Maine through legislation in 2003.

The transportation sector is responsible for just under one-third of Maine's contribution to global warming and more than one-third of its releases of carbon dioxide—the leading global warming gas. Cars and light trucks—such as pickups, minivans and SUVs—are the most important sources of global warming emissions in the transportation sector, responsible for about two-thirds of all transportation sector emissions and about one-fifth of Maine's total emissions of global warming gases.

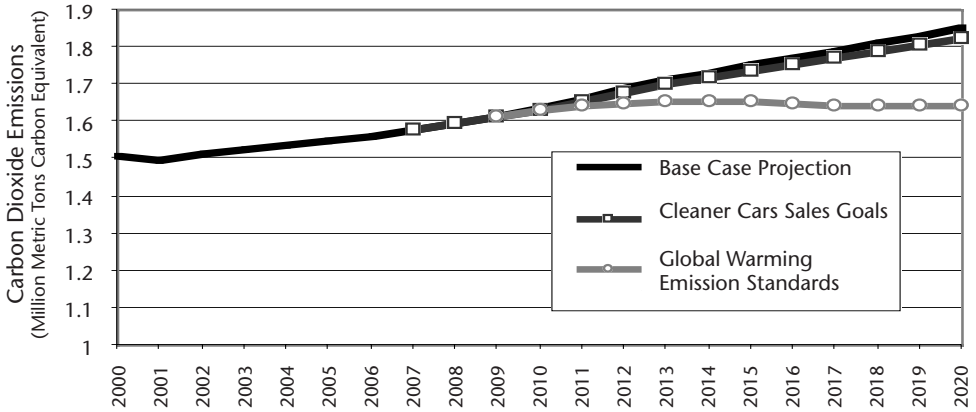
A number of public policies can reduce the contribution of cars and light trucks to global warming and help Maine meet its commitments.

Carbon dioxide emissions from cars and light trucks in Maine are likely to increase by approximately 41 percent over 1990 levels by 2020 unless action is taken to reduce emissions.

- The stagnation in federal corporate average fuel economy (CAFE) standards for cars and light trucks, the recent shift toward greater use of less fuel-efficient SUVs, and increasing vehicle travel have put Maine on a course toward dramatically increased emissions of carbon dioxide from transportation over the next two decades.

Maine can reduce its carbon dioxide emissions by implementing two policies to curb automobile emissions.

Fig. ES-1. Estimated Maine Carbon Dioxide Emissions from Cars and Light Trucks, 2000-2020, Under Policy Scenarios



- The Cleaner Cars Sales Goals program (also known as the "Zero Emission Vehicle" or "ZEV" program)—which has been adopted or is in the process of being adopted by California and six northeastern states—will pave the way for the widespread introduction of clean, advanced technology vehicles (such as hybrid-electric and fuel-cell vehicles) that could result in dramatic, long-term reductions in carbon emissions. In the process, it would lead to light-duty carbon dioxide emission reductions of about 1.5 percent below projected levels by 2020.
- California's forthcoming standards on global warming emissions from automobiles (also known as the "Pavley" standards for their original legislative sponsor) could produce significant reductions in vehicle carbon dioxide emissions. Adoption of a parallel program in Maine taking effect in model year 2009 would reduce carbon dioxide emissions from cars and light trucks by about 11 percent below projected levels by 2020 at a net economic benefit to the state.
- Even with the adoption of both policies, carbon dioxide emissions from cars and light trucks in 2020 would still be about 9 percent higher than emissions in 2000 because of a large projected increase in vehicle travel. Thus, Maine will likely need to adopt additional policies to reduce emissions from the transportation sector if it wishes to achieve the regional goal of reducing overall global warming emissions to 10 percent below 1990 levels by 2020.

Maine should move quickly to adopt policies that will stabilize, and ultimately reduce, emissions of carbon dioxide from cars and light trucks.

- The Maine Department of Environmental Protection should propose implementation of the Cleaner Cars Sales Goals program as an initial step to achieving Maine's emission reduction goals.
- In 2005, Maine should commit to adopting vehicle global warming emission standards identical to those that are being adopted by the state of California.
- Maine should adopt other programs – such as new incentives for the purchase of vehicles with lower global warming emissions, "smart growth" policies that reduce vehicle travel, transit improvements, and other measures – to reduce global warming emissions from the transportation sector.

Introduction

In 2001, Maine, in concert with other New England states and eastern Canadian provinces, took a bold step toward dealing with the problem of global warming by adopting a regional Climate Change Action Plan. The plan committed the region to significant reductions in emissions of global warming gases over the next two decades and even greater reductions in the future.

Reinforcing that commitment, in 2003 the Maine Legislature passed a law committing the state to meeting the same short- and medium-term goals as the regional action plan and setting in motion a planning process to determine how the state will achieve those goals. That planning process—which involves a diverse array of stakeholders from government, business, and the nonprofit sector—will be completed by mid-October 2004.

Meeting the state's global warming reduction goals will require Maine to reduce emissions from all sectors of the economy, including transportation, which is responsible for about one-third of the state's contribution to global warming.

The technology exists to reduce emissions from transportation, and particularly cars and light trucks, the largest source of transportation emissions. The tools to make less-polluting cars and trucks already exist, and can be implemented at little cost —or even a net economic benefit—to most consumers. Meanwhile, a host of newer technologies—ranging from hybrid-electric cars to fuel-cell vehicles that operate on hydrogen—could play an important role in meeting the region's long-term emission reduction goals.

A series of policy options exist that, if adopted, can ensure that Mainers have the opportunity to purchase and drive this exciting new generation of cleaner vehicles. Specifically, the Cleaner Cars Sales Goals program (adopted, or in the process of being adopted, by California, New York, New Jersey and all New England states except New Hampshire) and California's forthcoming standards for vehicle global warming emissions make important strides toward realizing the promise of new technologies to reduce the impact of our transportation system on the climate.

This report documents the impact that adoption of these two programs could have for reducing global warming emissions from motor vehicles in Maine. But it also documents the challenge the state faces in reining in emissions from the transportation sector. Even with adoption of the Cleaner Cars Sales Goals program and tailpipe emission standards for global warming gases, Maine will still need to take additional steps to curtail global warming emissions from transportation and achieve its overall climate protection goals.

Global Warming and Maine

Human activities over the last century —particularly the burning of fossil fuels—have changed the composition of the atmosphere in ways that threaten dramatic alteration of the global climate in the years to come. Those changes could have serious repercussions for Maine.

Causes of Global Warming

Global warming is caused by a blanket of pollution that traps solar radiation near the earth's surface. This pollution comes largely from cars, power plants, factories and homes when we burn fossil fuels such as coal, oil and gas—as well as from other human and natural processes.

Since 1750, the atmospheric concentration of carbon dioxide has increased by 31 percent. The current rate of increase in carbon dioxide concentrations is unprecedented in the last 20,000 years.[1] Concentrations of other global warming gases—such as methane and nitrous oxide—have increased as well.

As a result, global average temperatures increased during the 20th century by about 1° F. And, if current trends in global warming emissions continue, temperatures could rise by an additional 2.5° F to 10.4° F over the period 1990 to 2100.[2]

Potential Impacts of Global Warming

The impact of this increase in global temperatures will vary from place to place. Because the earth's climate system is extraordinarily complex, warming may be more or less extreme at various points on the globe and at different times during the year. Some regions will experience drier weather, others will receive more precipitation. Storm cycles will also likely be affected in unpredictable yet significant ways.

There is little doubt, however, that the first signs of global warming are beginning to appear, both in Maine and around the world. There is also little doubt that global warming could lead to dramatic disruptions in our economy, environment, and way of life.

Over the last century, for example, the average temperature in Lewiston has increased by 3.4° F.[3] Meanwhile, precipitation has decreased by 10 to 20 percent in parts of Maine.[4]

Should current emission trends continue, temperatures in Maine could increase by 2° F to 8° F by 2100.[5] Others estimate that a 1.8° F increase in average temperature could occur New England-wide as soon as 2030, with a 6° F to 10° F increase over current average temperatures by 2100.[6]

Precipitation levels also could change. Scientific models suggest that springtime precipitation will experience little change, while precipitation may increase by 10 percent in spring and fall and 30 percent in winter. (Though this is counter to the trend over the last century, as described above.)[7]

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

- Longer and more severe smog seasons as higher summer temperatures facilitate the formation of ground-level ozone, resulting in additional threats to respiratory health such as aggravated cases of asthma.[8]
- Increased spread of exotic pests and shifts in forest species—including the loss of maples, birches and beeches responsible for Maine's vibrant fall foliage displays. This decline would be more than aesthetic: fall foliage-related tourism accounts for 20 to 25 percent of annual tourism in Vermont and Maine.[9]
- Decreased maple syrup production as winters become warmer or dryer, reducing yields. By the end of the century, global warming may change the region's climate so dramatically that sugar maples no longer can survive in the region. This would be an economic blow: maple syrup production is a $20 million industry for New England.[10]
- Shifts in populations of fish, lobster, and other aquatic species due to changing water temperatures and changes in the composition of coastal estuaries and wetlands.[11]
- Increases in toxic algae blooms and "red tides," resulting in fish kills and contamination of shellfish.[12] This could threaten Maine's $45 million shellfishing industry.[13]
- Declines in freshwater quality due to more severe storms, increased precipitation and intermittent drought, potentially leading to increases in waterborne disease.[14]
- Increased coastal flooding due to higher sea levels, with sea levels projected to rise as much as 14 inches near Rockland.[15]
- Increased spread of mosquito and tick-borne illnesses, such as Lyme disease, West Nile virus and Eastern equine encephalitis.[16]
- Increased risk of heat-related illnesses and deaths.[17]

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

Global Warming Emissions in Maine

Based on a draft inventory compiled by Northeast States for Coordinated Air Use Management (NESCAUM), emissions of global warming gases in Maine increased by 14 percent between 1990 and 2000, to approximately 8.0 million metric tons carbon equivalent (MMTCE, see note on units below).[18] Of those emissions, about two-thirds were in the form of carbon dioxide released as a result of the combustion of fossil fuels.

Other Global Warming Emissions

This report focuses on transportation-related emissions of carbon dioxide—the leading gas responsible for global warming and the global warming gas released in the largest quantities by cars and trucks. Cars and trucks produce other global warming gases, however, that must be considered in any emission reduction strategy.

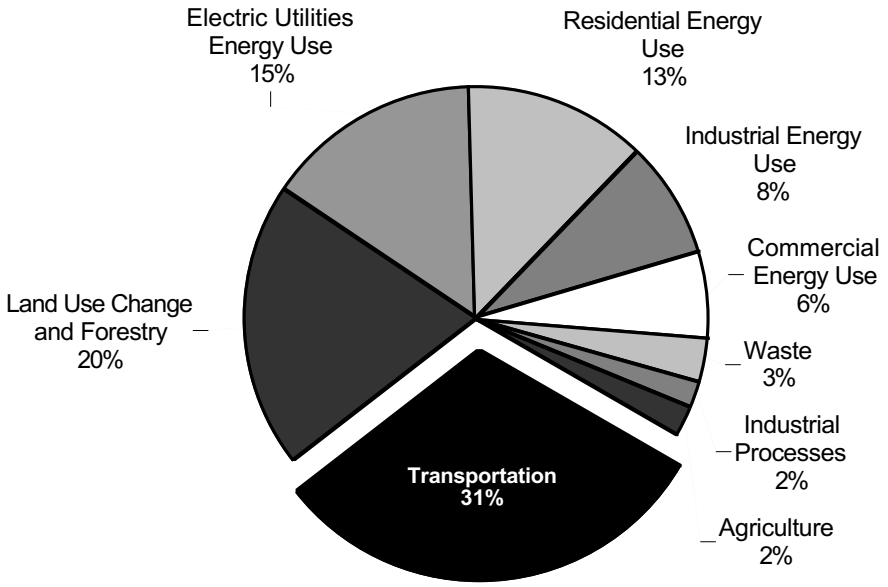
- **Methane** – Methane gas is likely the second-most important contributor to global warming in Maine. Cars and light trucks produce methane in their exhaust, but it is thought that they are only minor emitters of methane and that emissions will be reduced in the future through improved emission control systems.[19]
- **Nitrous Oxide** – Nitrous oxide is also produced in automobile exhaust, with mobile sources estimated to contribute about 13 percent of U.S. nitrous oxide emissions in 2002.[20] As with methane emissions, improved emission control measures may reduce nitrous oxide emissions in the future.
- **Hydrofluorocarbons (HFCs)** – HFCs are extremely potent global warming gases, yet tend to be released in only very small quantities. HFCs are typically used as coolants in vehicle air conditioning systems and can escape from those systems into the environment.
- **Black carbon** – Black carbon, otherwise known as "soot," is a product of the burning of fossil fuels, including diesel fuel used in heavy-duty trucks and a small percentage of light-duty vehicles. Recent research has suggested that, because black carbon absorbs sunlight in the atmosphere and on snow and icepack, 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.

A Note on Units

Because various gases contribute to global warming, and the potency of the warming effects of those gases varies, inventories of global warming emissions typically use units that communicate emissions in terms of their global warming potential.

In this report, we use units of "carbon equivalent"—the amount of carbon (in the form of carbon dioxide) that would need to be released to create a similar global warming effect. Other documents, including documents prepared for the Maine greenhouse gas stakeholder process, communicate emissions in terms of "carbon dioxide equivalent." To translate the carbon equivalent to carbon dioxide equivalent, one can simply multiply by 3.66.

Fig. 1. Maine Sources of Global Warming Emissions[22]



The transportation sector is responsible for just under one-third of Maine's contribution to global warming and more than one-third of its releases of carbon dioxide. (See Fig. 1.) Cars and light trucks – such as pick-ups, minivans and SUVs—are the most important sources of global warming emissions within the transportation sector, responsible for about two-thirds of all transportation-sector emissions and about one-fifth of Maine's total emissions of global warming gases.[21]

The Regional Climate Change Action Plan and Maine's Climate Change Reduction Efforts

Recognizing the threat global warming poses to Maine—as well as the opportunity for the state to make a significant contribution to reducing global warming emissions—in 2001, then-Gov. Angus King joined with other New England governors and premiers of eastern Canadian provinces in adopting a regional Climate Change Action Plan.

The plan set goals for the region to stabilize, and ultimately reduce, its emissions of global warming gases to the atmosphere. In the short term, the plan calls for regional global warming emissions to be reduced to 1990 levels by 2010. In the medium term, the region is committed to reductions of 10 percent below 1990 levels by 2020. And in the long term, the agreement calls for a reduction in global warming emissions sufficient "to eliminate any dangerous threat to the climate"—a level of reduction estimated by scientists at 75 to 85 percent below present-day levels.[23]

The plan also acknowledged the importance of the transportation sector to any effort to reduce overall global warming emissions, and committed the region to attempt to "slow the growth rate of transportation emissions in the near future."[24] Specifically, the plan recommended that the region "(p)romote the shift to higher efficiency vehicles, lower carbon fuels, and

advanced technologies through the use of incentives and education," among other efforts.[25]

Notable in the plan's language, however, is the failure to commit to specific, numerical goals for the reduction of global warming emissions from the transportation sector—even though similar goals were set for reductions from the electricity sector and the public sector, and for improvements in energy conservation. The reticence of the governors and premiers to make a concrete commitment on this issue represents a weak link in the agreement—one that could jeopardize the region's ability to meet its overall global warming emission reduction goals.

During the past two years, under the leadership of Gov. John Baldacci, Maine has reinforced its commitment to achieving the regional goals and has begun to develop a plan designed to achieve them. In May 2003, the governor signed a law committing the state to achieving the same goals for global warming emission reductions as established in the regional Climate Change Action Plan. The law also required the development of a state climate change action plan designed to meet those goals.

Since late 2003, the Department of Environmental Protection has been leading the efforts of a group of stakeholders representing business, government, academia and the nonprofit sector to develop recommendations for programs and policies to reduce the state's contribution to global warming from all sectors of the economy, including transportation.

Transportation and Global Warming: A Primer

A gallon of gasoline contains a set amount of carbon, nearly all of which is released to the atmosphere when it is burned. Some of the carbon is released in the form of hydrocarbons; most of it is released in the form of carbon dioxide. For each gallon of gasoline burned in a vehicle, about 19.6 pounds of carbon dioxide is released to the atmosphere. In addition, the consumption of gasoline creates significant additional "upstream" emissions of carbon dioxide resulting from the extraction, transportation, refining and distribution of the fuel. Other fuels have greater or smaller amounts of carbon in a gallon (or its equivalent).

Unlike other vehicular air pollutants that result from the incomplete combustion of fossil fuels or from fuel impurities, carbon dioxide is a natural result of the combustion process. As a result, there are three main ways to limit carbon dioxide emissions from motor vehicles:

1. Drive more efficient vehicles.
2. Reduce the number of miles traveled.
3. Switch to fuels with a lower carbon content.

Vehicles also emit smaller amounts of other global warming gases, such as methane and nitrous oxide, as well as hydrofluorocarbons from the use of the air conditioning system. Control of some of these emissions is possible through means other than reducing fuel use or substituting low-carbon fuels.

The Transportation Challenge

The challenge of reducing global warming emissions from cars and trucks is formidable, and growing increasingly so with each passing year.

Three recent trends in the transportation sector have made the challenge of reducing global warming emissions in Maine even greater.

Increasing Vehicle Miles Traveled

Mainers are traveling more miles in their cars and light trucks than ever before. Between 1985 and 2002, the number of vehicle-miles traveled (VMT) annually on Maine highways increased from 9.4 billion miles to 14.7 billion miles—an increase of 56 percent.[26]

Stagnating Fuel Economy

The imposition of federal Corporate Average Fuel Economy (CAFE) standards beginning in 1975 led to dramatic improvements in the fuel efficiency of American cars and light duty trucks. The CAFE standards required a gradual increase in fuel economy during the 1970s and 1980s, topping out at an average fuel economy for new cars of 27.5 miles per gallon (MPG) by 1990 and 20.7 MPG for light trucks by 1996.[28] (The National Highway Traffic Safety Administration recently increased the light truck standard to 22.2 MPG, to be achieved by model year 2007.)

In the decade-and-a-half following enactment of the CAFE standards, the "real world" fuel economy of passenger cars nearly doubled—from 13.4 MPG in 1975 to 24.0 MPG in 1988. Similarly, light trucks experienced an increase in real-world fuel economy from 11.8 MPG in 1975 to 18.3 MPG in 1987.[29]

However, the momentum toward more fuel efficient cars has not only stalled since the late 1980s, but it has actually reversed. Indeed, in many cases, Americans get fewer miles per gallon from their new vehicles today than they did during the Reagan administration.

Until recently, the federal government had refused to increase CAFE standards for more than a decade, and changes in driving patterns—including higher speeds and increased urban driving—have led to a real-

Fig. 2. Maine VMT Increased More than 56 percent Between 1985 and 2002[27]

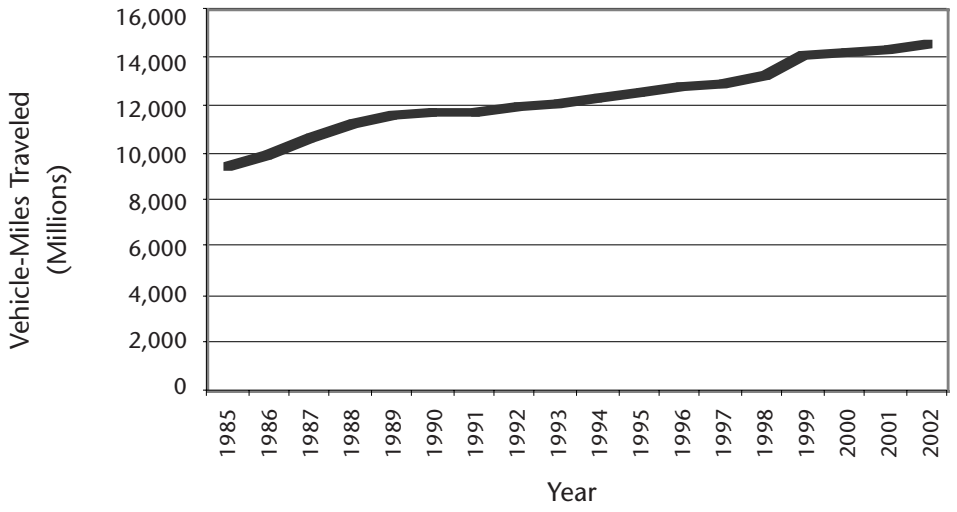
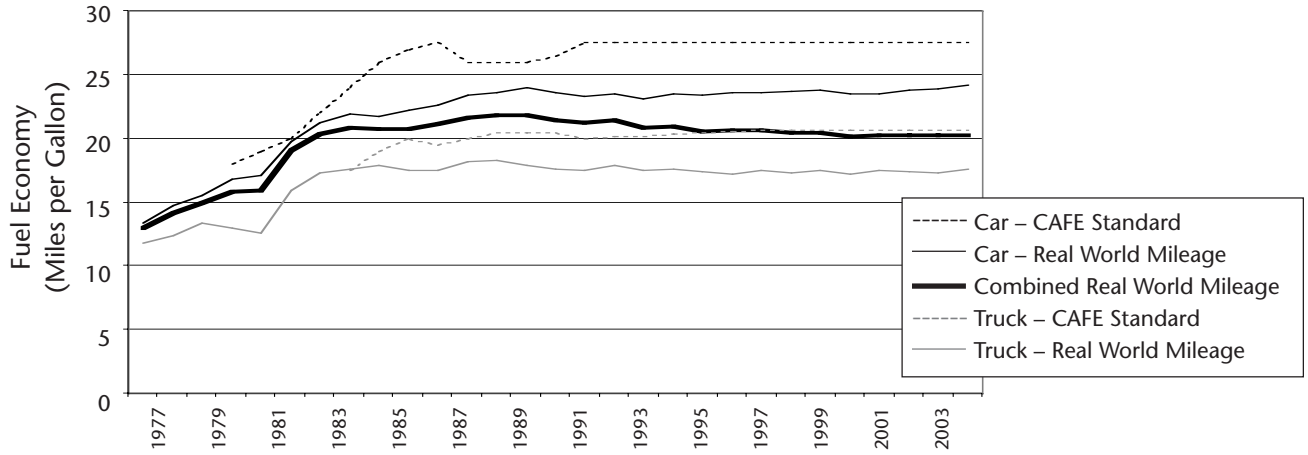


Fig. 3. Average Fuel Economy for New Light-Duty Vehicle Fleet on the Decline[31]



world decrease in fuel economy. An EPA analysis of fuel economy trends found that the average real-world fuel economy of light-duty vehicles sold in 2003 was lower than the average fuel economy of vehicles sold in 1981. Indeed, the average real-world fuel economy of new cars and light trucks actually *declined* by 7 percent between 1988 and 2003.[30]

Amid growing public pressure to improve vehicle fuel economy, the U.S. Department of Transportation plans to increase CAFE standards for light trucks by a modest 1.5 MPG between 2005 and 2007. While this proposal fails to take advantage of many technologies that could cost-effectively improve fuel economy, even a modest increase in CAFE standards has some effect in reducing the rate of growth of transportation carbon dioxide emissions.

The Shift to SUVs and Light Trucks

While the fuel economy of the average car and light truck has stagnated over the past two decades, the average fuel economy of the entire new-car fleet has declined—thanks to the dramatic shift in purchasing habits toward sport utility vehicles (SUVs), vans and light trucks.

In 1975, when the first federal CAFE standards were enacted, SUVs made up 2 percent of the light-duty vehicle market, vans 5 percent, and pickup trucks 13 percent. By model year 2004, however, SUVs accounted for 26 percent of light-duty vehicle sales, vans 7 percent, and pickup trucks 15 percent. The light-duty market share of passenger cars and station wagons dropped over the same period from 81 percent to 52 percent.[32]

Fig. 4 (a-c). Light-Duty Vehicle Purchasing Shifts from Cars to Trucks, Vans and SUVs

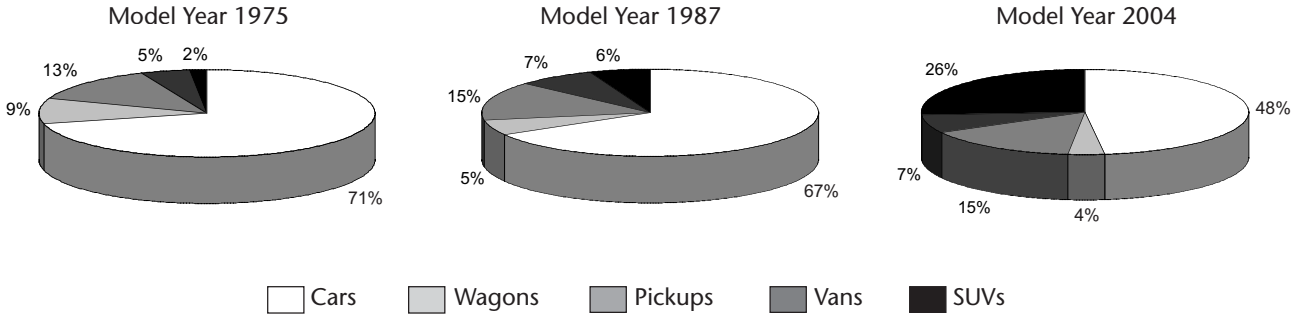
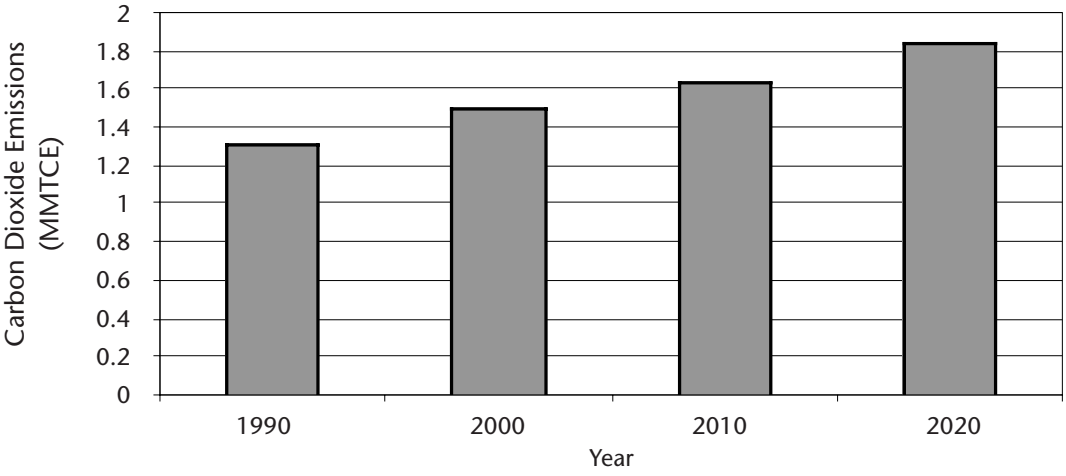


Fig. 5. Actual and Projected Carbon Dioxide Emissions from Light-Duty Vehicles in Maine, 1990-2020



This shift in purchasing habits has caused the average fuel economy of the entire new light-duty vehicle fleet to dip as low as 20.4 MPG in 2001—lower than at any time since 1980 and down by nearly 8 percent from the historical peak in 1987 and 1988.[33]

The trend toward SUVs and light trucks is expected to continue, with light trucks making up an increasing percentage of the entire light-duty fleet as time goes on. The Environmental Protection Agency projects that by 2020, 64 percent of all light-duty vehicles on the road will be light trucks.[34]

The combination of these three factors—more miles traveled, increasingly in trucks and SUVs, with stagnant fuel economy across the entire vehicle fleet—poses a great challenge to Maine policymakers as they attempt to reduce global warming emissions from the transportation sector.

Vehicle Carbon Dioxide Emissions in Maine: Past and Future

Based on Maine-specific fuel consumption data compiled by the U.S. Energy Information Administration (EIA), cars and light-duty trucks released approximately 1.3 million metric tons carbon equivalent (MMTCE) of carbon dioxide into the atmosphere in 1990. By 2000, those emissions had increased by about 15 percent, to 1.5 MMTCE—meaning that cars and trucks were responsible for approximately one-fifth of Maine's contribution to global warming in 2000.[35]

Any attempt to project Maine's future global warming emissions depends greatly on the assumptions used. The "Assumptions and Methodology" section at the conclusion of this report describes these assumptions in detail. Simply put, the following projections (which are based largely on data and projections by state and federal government agencies and which we will term the "base case") assume continued growth in vehicle travel, slight improvement in vehicle fuel economy, and a continuation of the trend toward increased purchases of sport utility vehicles and other light trucks.[36]

Based on these assumptions, carbon dioxide emissions from the Maine light-duty vehicle fleet are projected to experience an 8 percent increase over 2000 levels by 2010, followed by a further 13 percent increase between 2010 and 2020. In other words, by 2020, carbon dioxide emissions from cars

and light trucks will exceed 1990 levels by 41 percent in the absence of action to reduce emissions. (See Fig. 5.)

An increase of such magnitude would severely challenge Maine's ability to meet its global warming emission reduction goals. Should these increases in emissions from cars and light trucks occur, Maine would need to achieve dramatic reductions in global warming emissions from other sectors of the state's economy over the next two decades in order to meet the goals of the plan.

However, this path toward increasing carbon dioxide emissions from cars and light trucks is not inevitable. Public policies that require or encourage the purchase of more fuel-efficient or advanced technology cars can make a significant dent in Maine's future emissions of global warming gases. Among the most powerful such policy options are the requirements for hybrid and zero-emission vehicles adopted by California and six northeastern states, and forthcoming limits on vehicle global warming emissions recently adopted in California.

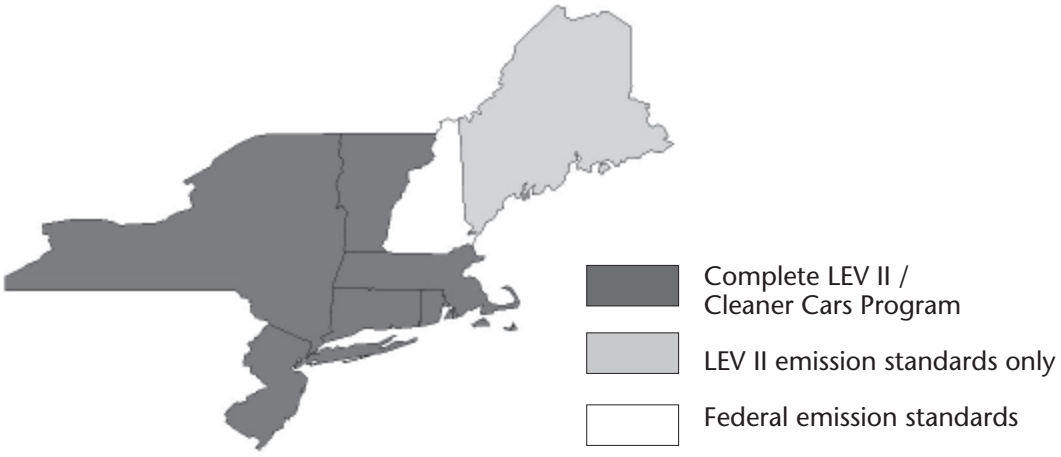
Tools to Reduce Global Warming Emissions from Cars and Light Trucks

Maine has many potential tools available to reduce emissions of global warming gases from the transportation sector. Among the most powerful of those tools are the Cleaner Cars Sales Goals that are part of the Low Emission Vehicle Program for cars and trucks first adopted in California.

The Clean Air Act gives most states two options for control of motor vehicle emissions: states may choose to comply with federal emission standards or adopt the more protective "CALEV" standards implemented by the state of California, the only state empowered by the Clean Air Act to devise its own emission regulations.

Maine—like six other states in the Northeast—has chosen to implement CALEV standards for smog-forming and other pollutants (which were updated in the late 1990s and are now known as the Low Emission Vehicle II, or LEV II, standards). Unlike those six states, however, Maine has not yet implemented accompanying standards that require the gradual introduction of ultra-clean advanced-technology vehicles (the Cleaner Cars Sales Goals program). (See Fig. 6.)

Fig. 6. Northeast States Adopting the LEV II Standards and the Cleaner Cars Sales Goals



In addition, Maine and other states will soon have the opportunity to adopt forthcoming standards to limit global warming emissions from cars and light trucks. The standards will likely bring about significant reductions in carbon dioxide emissions from cars and light trucks over the next decade.

Adoption in Maine of the Cleaner Cars Sales Goals and global warming emission standards would likely result in significant reductions in emissions of global warming gases from cars and trucks, providing important assistance in Maine's efforts to meet the state's climate change goals.

Cleaner Cars Sales Goals Program

The Cleaner Cars Sales Goals program has been transformed in recent years from a program directed at supporting the introduction of battery-electric vehicles to a program that seeks to bring a wide variety of advanced automotive technologies to market—especially hybrid-electric vehicles. The emphasis of the program is on reducing emissions of smog-forming and other hazardous pollutants. It is likely, however, that some of the technological changes encouraged by the Cleaner Cars Sales Goals will also reduce emissions of global warming gases as well.

The Cleaner Cars Sales Goals program calls for the sale of increasing percentages of advanced-technology vehicles over the next decade and more. The program currently has three main components:

Pure Zero-Emission Vehicles

"Pure" zero-emission vehicles (pure ZEVs) are those—like battery-electric and fuel-cell vehicles—that release no harmful pollutants from their tailpipes or fuel systems. Battery-electric vehicles (which are recharged from the electric grid) do not even have tailpipes, while hydrogen fuel-cell vehicles emit only water and heat.

The most recent revision to the Cleaner Cars Sales Goals program shifted the emphasis of the program from near-term deployment of battery-electric vehicles to the long-term development of hydrogen fuel-cell vehicles. Should Maine adopt the goals program, automakers would face no requirement to sell fuel-cell or other pure zero-emission vehicles until at least model year 2012. Even then, the number of pure ZEVs required for sale in Maine would be small, representing less than one percent of new car and light truck sales until model year 2018.[37] Northeast States for Coordinated Air Use Management (NESCAUM), a regional organization of state air quality officials, estimates that approximately 170 fuel-cell vehicles would be sold in Maine in 2013, rising to approximately 580 in 2020.[38]

In addition, the California Air Resources Board (CARB), which administers the program, is scheduled to review the status of fuel-cell technology prior to enforcing any pure ZEV requirements for the 2009 model year and beyond.[39]

The current incarnation of the Cleaner Cars Sales Goals program, therefore, requires the sale of very few pure zero-emission vehicles over the next decade. But it does provide an incentive for automakers to continue research and development work on technologies such as hydrogen fuel-cell vehicles that could provide zero-emission transportation in the future.

Partial Zero-Emission Vehicle (PZEV) Credits

The majority of vehicles that automakers produce to comply with the Cleaner Cars Sales Goals will be vehicles that receive "partial ZEV credit"—otherwise known as "PZEVs." PZEVs are like conventional gasoline vehicles in every way but one: they are engineered to produce dramatically lower emissions of smog-forming and other hazardous pollutants. Indeed, PZEVs are 90 percent cleaner than the average new

vehicle sold today.[40] There are many current models of vehicles that meet the standards, although not all are made available outside of California and other states that have adopted the Cleaner Cars Sales Goals program.

Automakers have the opportunity to fulfill about 60 percent of their Cleaner Cars Sales Goals program obligations with PZEVs. Should they choose to do so in Northeast states such as Massachusetts and New York that have already adopted the program, PZEVs will represent about 30 percent of new passenger car sales in those states beginning in model year 2007. In Maine, such a requirement would result in the sale of more than 10,000 PZEVs per year beginning in 2008 (when model year 2009 vehicles—the first vehicles covered by the program—will arrive in showrooms), rising to nearly 15,000 per year by 2013.

As demonstrated by the experience in other states, these sales targets and deadlines are achievable. Twenty-seven models of model year 2004 vehicles have already been certified as PZEVs by the California Air Resources Board and more than 140,000 were estimated to have been sold in 2004.

The added cost of these cleaner vehicles to the consumer has proven to be minimal thus far—in many cases under $100 for a cleaner vehicle with an extended emission system warranty.[41]

While PZEVs would play an important role in helping Maine to achieve its air quality goals, the technologies used in PZEVs do not necessarily make a substantial contribution to reducing global warming emissions from cars. Thus, we do not assume any global warming benefits from the PZEV portion of the program.

Advanced Technology PZEVs (AT-PZEVs)

The greatest near-term global warming impact of the Cleaner Cars Sales Goals program will likely come from provisions to encourage the sale of PZEVs that also run on a cleaner alternative fuel, such as compressed natural gas, or that use advanced technologies, such as hybrid-electric drive. These are known as "advanced technology PZEVs" or "AT-PZEVs." To encourage automakers to release additional new hybrid vehicles as early as possible, automakers are allowed to comply with up to 40 percent of their Cleaner Cars Sales Goals program obligations in the early years of the program through the sale of AT-PZEVs.

Hybrid-electric vehicles are the most likely technology to be used to comply with AT-PZEV standards. Hybrids have proven to be very popular with consumers, especially in an era of higher and rapidly fluctuating gasoline prices. Sales of hybrid vehicles have increased steadily since their introduction to the domestic market in December 1999. About 43,000 hybrids were sold in the U.S. in 2003, an increase of 26 percent from the previous year.[42] Since 2000, hybrid sales have grown at an average annual rate of 89 percent.[43] Toyota reports that sales of the Prius in early 2004 had doubled compared to the same period in 2003.[44]

Hybrids have also proven popular in Maine. As of July 2004, there were more than 500 hybrid vehicles registered in the state.[45] Through May, Maine auto dealers had already sold more than 150 hybrids in 2004, with waiting lists of 6 to 18 months for the hottest-selling hybrid, the Toyota Prius.[46]

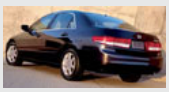
Thus far, there are three models of vehicles that have been certified to AT-PZEV emission standards: the hybrid Toyota Prius and Honda Civic and the natural gas-powered Honda Civic GX.[47] (The recently introduced Ford Escape hybrid also meets AT-PZEV standards.)[48] Unfortunately, although a healthy market for hybrids appears to exist, automakers have not yet supplied hybrids in large enough quantities to meet consumer demand. In addition to the long waiting lists for current hybrids,

Upcoming Hybrid Vehicles

With the market success of pioneering hybrid-electric vehicles such as the Toyota Prius, automakers are preparing to release many new hybrid vehicles to the market in the years to come.[51]

Ford Escape – Introduced this year, the Ford Escape hybrid is the world's first full hybrid SUV. With a hybrid system similar to that of the Toyota Prius, the EPA rates the Escape's fuel economy at 31 MPG on the highway and 36 MPG in the city, making it the most fuel-efficient SUV on the market.[52]

GMC Sierra/Chevy Silverado – GM has included a hybrid option on its full-size pickup trucks that provides an estimated 5 to 13 percent boost in fuel economy. The EPA rates the fuel economy of the two wheel drive versions of the hybrid pickups at 18 MPG city/20 MPG highway.[53]



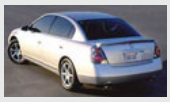
Honda Accord – Honda plans to introduce a hybrid version of its popular Accord in late 2004, joining Honda's Civic and Insight hybrids. The hybrid Accord will also employ technology that allows for the deactivation of three of the gasoline engine's six cylinders during highway cruising to further improve fuel economy.[54] The hybrid Accord is expected to get 32 miles per gallon in the city and 38 MPG on the highway.[55]

Lexus RX400H – Billed as the first luxury hybrid, the RX400H will incorporate a more powerful version of the Toyota hybrid system used in the Prius. Scheduled to debut in early 2005, Lexus dealers have reportedly received deposits for 8,000 of the 20,000 vehicles they plan to sell in the first year. The RX400H is expected to achieve a fuel economy rating of 28 MPG, compared to 21 MPG for its conventional equivalent.[56]

Toyota Highlander – In early 2005, Toyota plans to introduce a hybrid version of its Highlander SUV. It is expected to achieve similar performance to the Lexus RX400H.

Dodge Ram – DaimlerChrysler plans to introduce a hybrid version of its Ram pickup truck that will also double as a remote electric generator.

Saturn VUE – Projected for launch in early 2006, the Saturn VUE hybrid is expected to achieve a fuel economy improvement of approximately 12 percent.[57]



Nissan Altima – Nissan plans to launch a hybrid version of its Altima sedan in the U.S. during 2006. The vehicle will use hybrid technology developed by Toyota.[58]

Other – Toyota plans to offer a hybrid version of its Sienna minivan in 2005. General Motors plans to introduce hybrid versions of the Chevy Equinox and Malibu, as well as the Chevy Tahoe and GMC Yukon SUVs during model year 2007. Ford plans to introduce a yet-to-be-named hybrid sedan in 2006 and a hybrid version of its Mercury Mariner SUV in 2007. Lexus intends to market a hybrid version of its LS430 sedan in 2007.[59]

at least one auto dealer in Maine has established a waiting list for the new Toyota Highlander hybrid SUV that will not even hit the market until the beginning of 2005.[49]

By the end of 2005, the demand crunch could ease as automakers plan to introduce at least six additional hybrid models—including hybrid versions of the Honda Accord and Toyota Highlander—which could qualify for AT-PZEV credit.[50] (See "Upcoming Hybrid Vehicles," page 19.) The presence of the AT-PZEV requirement could ensure that automakers continue to provide enough hybrids to the market in Maine to satisfy consumer demand.

Should automakers choose to maximize their use of AT-PZEVs to comply with the Cleaner Cars Sales Goals program – and do so using vehicles similar to the Toyota Prius—hybrids could make up about 5 percent of car and light truck sales in 2008, increasing to 7 percent by 2012 under the ZEV program. (See Fig. 7.) This translates to sales of about 1,600 hybrids in Maine in 2008, increasing to more than 4,000 annually by 2016. Because the Cleaner Cars Sales Goals program offers a great deal of flexibility, however, automakers could choose to comply by manufacturing greater numbers of less-advanced hybrids or smaller numbers of pure ZEVs, among other options.

Also unclear is the degree of global warming gas reductions that can be expected from vehicles complying with AT-PZEV standards. Hybrid-electric vehicles and alternative-fuel vehicles vary greatly in their emissions of global warming gases. Some, like the Toyota Prius, offer great reductions in global warming emissions. Others, such as hybrid pickup trucks to be sold by General Motors and Daimler-Chrysler, offer little reduction in global warming emissions versus conventional models. The Cleaner Cars Sales Goals program does provide additional credit to hybrid-electric vehicles that attain a greater share of their power from an electric motor (generally allowing them to achieve lower carbon dioxide emissions), but these credits are not directly tied to global warming emissions. For the purposes of this analysis, we assume that hybrids manufactured to comply with AT-PZEV standards will release about 30 percent fewer global warming gases per mile than conventional vehicles.[60]

Fig. 7. Cleaner Cars Sales Goals Program Percentage of Light-Duty Vehicle Sales, 2007 through 2020 (Estimated)

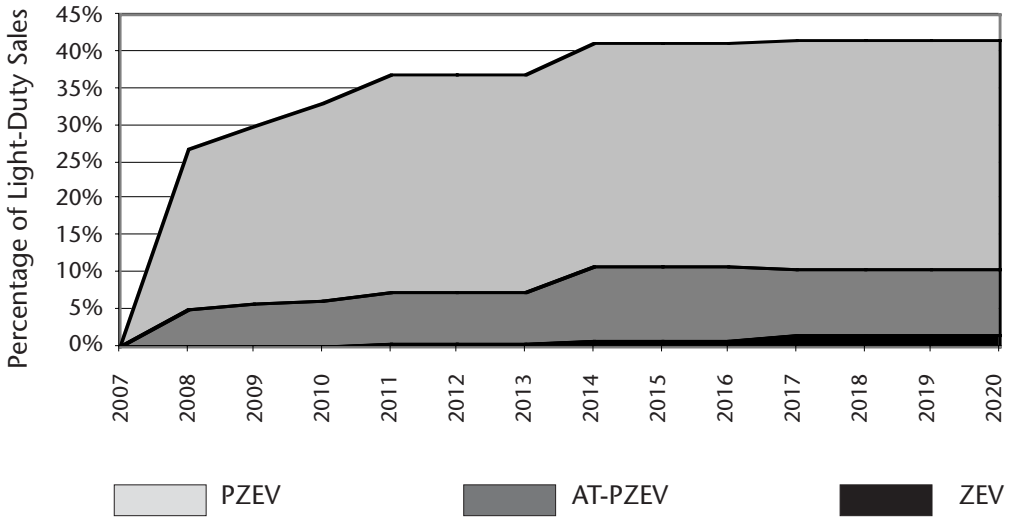
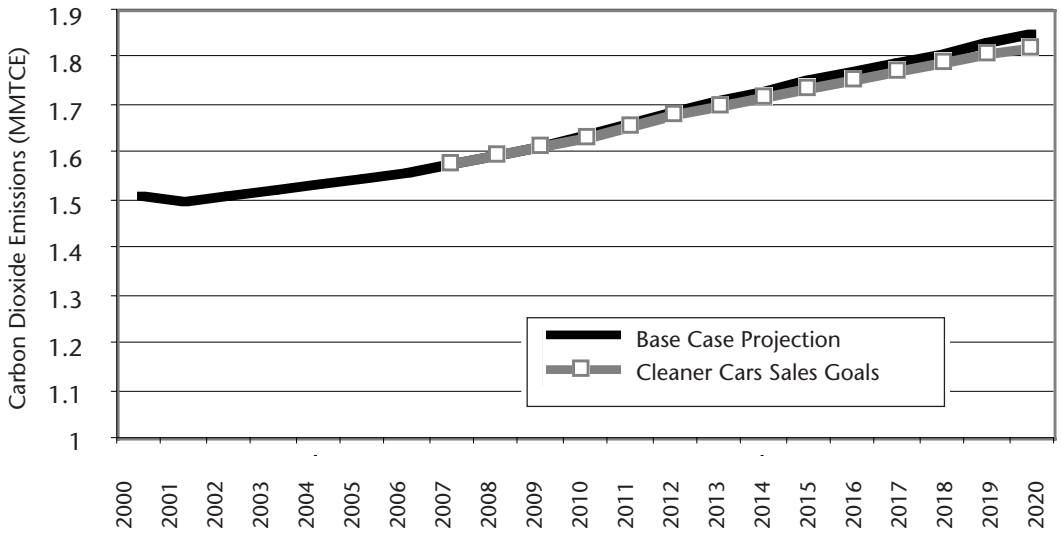


Fig. 8. Reductions in Carbon Dioxide Emissions Under Cleaner Cars Sales Goals Program (Light-Duty Vehicles)



Cleaner Cars Sales Goals Program Impacts: Long Term

On the front end, no assessment of short-term global warming emission reductions can precisely capture the potential long-term and indirect benefits of the Cleaner Cars Sales Goals program in reducing carbon dioxide emissions. At its heart, the program is a "technology forcing" program —one that attempts to jump-start advanced technology vehicle development and the adoption of these technologies in the mainstream auto market. That being said, however, adoption of the program will likely bring about significant long-term emission reductions as technological changes brought about by the program spread to other vehicles in the Maine car and truck fleet.

An example of the potential power of the program to hasten technological change is the development of hybrid vehicles. California's adoption of the original ZEV requirement sparked public and private-sector research efforts into the development of advanced batteries and electric-drive technologies. While the generation of full-function electric vehicles that resulted from that research—such as Honda's EV-Plus and General Motors' EV1—were not sold in large quantities, the research effort drove advances in electric vehicle technology that facilitated the birth of the popular hybrid-electric systems that now power tens of thousands of vehicles worldwide and have laid the groundwork for recent advances in fuel-cell vehicle technology.[61]

Similarly, the current form of the Cleaner Cars Sales Goals program is designed to encourage continued investment in hybrid-electric and hydrogen fuel-cell vehicle development and may lead to the development of new types of vehicles (such as "plug-in hybrids" that combine the benefits of battery-electric and hybrid-electric vehicles) with significant benefits for the climate. Once developed and offered to consumers, it is possible that these vehicles could come to represent a far greater share of the new car market than is estimated below.

Cleaner Cars Sales Goals Program Impacts: Short Term

The short-term impact of the Cleaner Cars Sales Goals program on carbon dioxide emissions in Maine would largely be determined by how automakers choose to comply with the program's flexible provisions. There are almost infinite options available to automakers for compliance—however, it is likely that one or several technologies will dominate the mix of vehicles certified under the program.

We assume that automakers will take maximum advantage of the ability to meet Cleaner Cars Sales Goals program requirements with PZEVs and AT-PZEVs. We also assume that vehicles sold to meet AT-PZEV requirements are hybrid-electric vehicles with similar technological characteristics to the Toyota Prius. We assume that any vehicles sold to meet pure ZEV requirements are hydrogen fuel-cell vehicles whose fuel is generated from natural gas. And we use conservative assumptions about the carbon dioxide emission reductions that could result from hybrid or fuel-cell vehicles.

Using these assumptions, implementation of the program in Maine beginning in the 2009 model year would reduce light-duty vehicle carbon dioxide emissions by about 1.5 percent versus base case projections by 2020—for a total reduction in emissions of about 0.027 MMTCE. (See Fig. 8, previous page.)

Vehicle Global Warming Emission Standards

In July 2002, California took another step toward reducing emissions from motor vehicles by adopting the first law to control carbon dioxide emissions from automobiles. Beginning in model year 2009, automakers will have to adhere to fleet average emission limits for carbon dioxide similar to current limits on smog-forming and other pollutants.

The California legislation requires CARB to propose limits that "achieve the maximum feasible and cost effective reduction of greenhouse gas emissions from motor vehicles." Limits on vehicle travel, new gasoline or vehicle taxes, or limitations on ownership of SUVs or other light trucks cannot be imposed to attain the new standards.[62]

On September 24, 2004, CARB adopted rules for implementation of the global warming emission standards. The final regulations are substantially similar to those proposed by CARB's staff in August 2004. Because the final regulations had not been adopted by the time data analysis for this report was completed, we relied on the August 2004 CARB staff proposal as the basis for our estimates of the impact of the program.

In developing the global warming emission standards, the CARB staff reviewed several analyses of the types of technologies that could be used to achieve "maximum feasible and cost effective" reductions in global warming emissions from vehicles. CARB's August 2004 proposal estimated that near-term technologies could reduce average global warming emissions from cars by 25 percent and from light trucks by 18 percent. Over the medium term (2013 to 2016), cost-effective reductions of 34 percent for cars and 25 percent for light-trucks are feasible.[63]

The technological changes needed to achieve these reductions (such as five and six-speed automatic transmissions and improved electrical systems) will likely result in modest increases in vehicle costs that would be more than recouped over time by consumers in the form of reduced fuel expenses. CARB projects that cars attaining the 34 percent reduction in global warming emissions required by 2016 would cost approximately $1115 more for consumers, while light trucks achieving the required 25 percent reduction would cost about $1341 more.[64]

However, the agency also estimates that the rules will significantly reduce operating

costs for new vehicles—particularly for fuel. By subtracting operating cost savings from the projected additional monthly payment associated with purchasing vehicles that comply with the standard, CARB projects that, upon full phase-in, consumers will save $3 to $7 every month as a result of the standards. CARB also projects that the net impact of the standards to the state's economy will be positive, suggesting that ***Maine could save money while at the same time reducing the state's overall emissions of global warming gases.***[65]

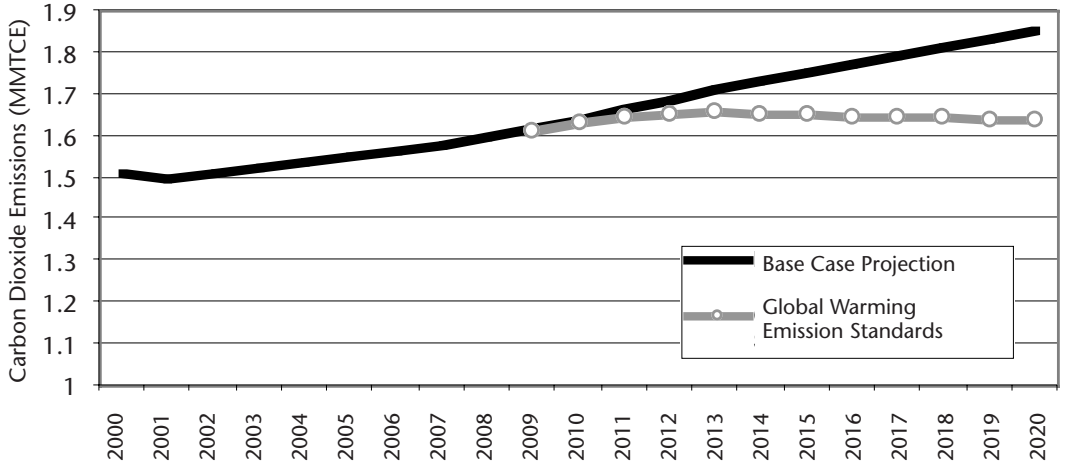
Assuming that the August 2004 version of the global warming emission standards are adopted as proposed—and that Maine would implement those standards beginning with the 2009 model year—the reductions in global warming emissions that would result would be significant. Compared to the base case projection, the emission standards would reduce light-duty carbon dioxide emissions by 11 percent by 2020—for a total reduction of 0.19 MMTCE. (See Fig. 9.)

While the global warming emission reductions projected for the tailpipe standards appear to be much larger than those of the Cleaner Cars Sales Goals program, the standards build upon the technological advances made possible by the latter program and would be far less effective without it. For example, a recent CARB analysis evaluated the cost-effectiveness of various hybrid-electric vehicle options over the long term. Because the Cleaner Cars Sales Goals program encourages the increased production and sale of hybrids, it can help to bring about volume production that reduces vehicle costs and makes hybrids and other advanced-technology vehicles more cost-effective long-term options for reducing global warming emissions from cars and light trucks.

The Need for Additional Actions

Together, the Cleaner Cars Sales Goals program and global warming emission standards can play an important role in Maine's efforts to reduce global warming emissions from the transportation sector. With adoption of the two programs, emissions from light-duty cars and trucks would be only 9 percent greater in 2020 than they were in 2000, compared to 23 percent greater if no action is taken.

Fig. 9. Reductions in Carbon Dioxide Emissions Under Global Warming Emission Standards (Light-Duty Vehicles)



Thus, adoption of both the Cleaner Cars Sales Goals program and emission standards would likely not be enough to achieve Maine's commitments under the Conference of New England Governors and Eastern Canadian Premiers Climate Change Action Plan. Should Maine seek to achieve reductions similar to those called for in the plan for cars and light trucks, the state would need to achieve an additional 0.32 MMTCE of reductions by 2010 and 0.46 MMTCE of reductions by 2020—a level of savings greater than that produced by adoption of these two programs.

A number of policy options exist for closing this gap, including:

- **Measures to reduce per-mile global warming emissions from vehicles, such as:**
  - State or federal incentives for the purchase of vehicles with lower carbon emissions
  - Standards requiring the sale of low rolling resistance tires, which can improve fuel economy by 3 percent versus conventional replacement tires[66]
  - Increases in federal corporate average fuel economy (CAFE) standards.
- **Measures to reduce the rate of growth in vehicle travel, such as:**
  - Adoption of "pay-as-you-drive" insurance, in which insurance is charged by the mile, discouraging excessive driving
  - Implementation of "smart growth" measures to reduce sprawling development and the accompanying need for vehicle travel
  - Improvements in transit service and other alternatives to automobile use.[67]

Policy Findings

Attaining the reductions in carbon dioxide emissions required of Maine under the regional Climate Change Action Plan will require significant actions to reduce emissions from light-duty vehicles.

To achieve this goal:

- The Maine Department of Environmental Protection should include adoption of the Cleaner Cars Sales Goals program in its climate change action plan and begin the process of moving toward adoption of the program by the end of 2004.
- The state should announce its commitment to adopt California's global warming emission standards for cars and light trucks at the earliest possible date.
- Maine should take aggressive action to reduce transportation-sector global warming emissions, including actions that speed the deployment of environmentally preferable advanced-technology vehicles (such as hybrids), reduce the rate of growth in vehicle travel, and encourage improvements in the fuel economy of conventional vehicles.

Assumptions and Methodology

Projections of future global warming emissions from automobiles depend a great deal on the assumptions used. This section details the assumptions we made about future trends, explains the methodology we used to estimate the impact of various programs, and compares the results with data recently published by others.

Baseline Light-Duty Vehicle Carbon Dioxide Emissions

Carbon dioxide emissions from light-duty vehicles (cars and light trucks) in Maine in 1990 and 2000 were based on state-specific motor gasoline usage data from U.S. Department of Energy, Energy Information Administration (EIA), *State Energy Data 2000 Consumption*, downloaded from www.eia.doe.gov/emeu/states/_use_multistate.html, 30 June 2004. Fuel consumption data for the transportation sector in BTU was converted to carbon dioxide emissions based on conversion factors from EIA, *Annual Energy Outlook 2003*, Appendix H and EIA, *Emissions of Greenhouse Gases in the United States 2001*, Appendix B. The proportion of transportation-sector gasoline emissions attributable to light-duty vehicles was estimated by dividing energy use by light-duty vehicles by total transportation-sector motor gasoline use as reported in EIA, *Annual Energy Outlook 2003*.

Vehicle-Miles Traveled

Historic and projected vehicle-miles traveled data for Maine were obtained from Edward Hanscom, Bureau of Planning, Maine Department of Transportation, 23 October 2003. An adjustment was made to Maine DOT's projections of future VMT, since the department's projected annual VMT growth rate of approximately 0.9 percent lags well below the actual growth rate experienced by Maine during the 1990 to 2002 period (approximately 1.9 percent).

For the purposes of this analysis, we assumed a rate of growth midway between that projected by Maine DOT and that experienced in Maine over the past dozen years, or 1.4 percent. (See Fig. 10.)

VMT Percentages by Vehicle Type

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

Fig. 10. Vehicle-Miles Traveled, Historic and Projected

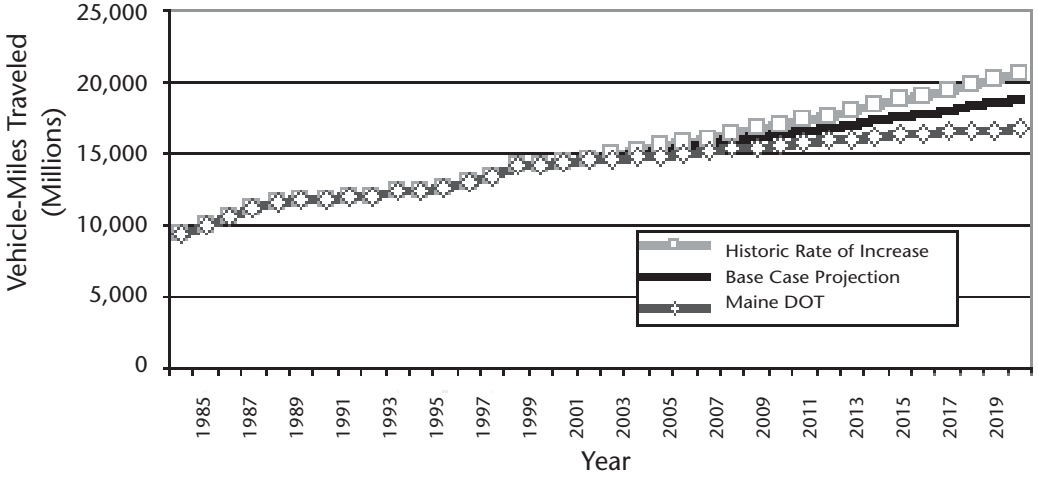
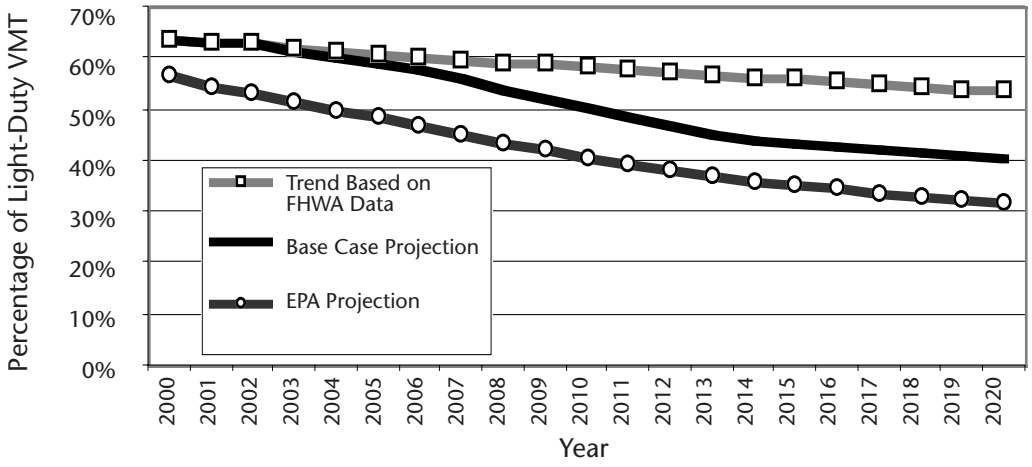


Fig. 11. Percentage of Light-Duty Vehicle-Miles Traveled in Cars



2000 through 2002 from the Federal Highway Administration, *Highway Statistics* series of reports and projections of future VMT splits output from the EPA's MOBILE6 mobile source emission estimating model. (Maine-specific data on VMT splits are unavailable, but the ratio of registered cars to trucks in Maine is similar to the national average according to Federal Highway Administration, *Highway Statistics 2002*, October 2003, Table MV-1.)

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

In order to estimate a trend that reflects both the more car-heavy current makeup of VMT and the long-term trend toward increasing travel in light trucks, we created two curves, one extrapolating the continued linear decline in the car portion of light-duty VMT based on trends in FHWA data from 1990 to 2002 and another using the EPA MOBILE6 estimates. We then assumed that the split in VMT would trend toward the EPA estimate over time, so that by 2020, cars are responsible for approximately 40 percent of light-duty VMT. (See Fig. 11.)

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.

VMT Percentages by Vehicle Age

Vehicle-miles traveled by age of vehicle were determined based on VMT accumulation data presented in 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.

Vehicle Carbon Dioxide Emissions

Per-mile carbon dioxide emissions from vehicles were based on assumed levels of carbon dioxide emissions per gallon of gasoline (or equivalent amount of other fuel), coupled with assumptions as to miles-per-gallon fuel efficiency.

For conventional vehicles, a gallon of gasoline was assumed to produce 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 were based on EPA laboratory fuel economy values from EPA, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004*, April 2004, multiplied by a degradation factor of 0.9 for years 2000 through 2020. (The degradation factor represents the degree to which real-world fuel economy falls below that reported as a result of EPA testing.) This choice of degradation factor differs significantly from those used in national-level analyses by EPA and EIA and is intended to reflect Maine's higher proportion of rural highway travel versus the national average.

For hybrid-electric vehicles used to comply with AT-PZEV requirements, fuel economy was estimated to exceed that of conventional vehicles by 45 percent, per National Research Council, National Academy of Engineering, *The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs [prepublication draft]*, the National Academies Press, 2004. This same document provided the assumption that hydrogen fuel-cell vehicles would achieve 140 percent greater fuel economy than conventional vehicles. This figure was then input into the Argonne National Laboratory's Greenhouse Gases Regulated Emissions and Energy Use in Transportation (GREET) model version 1.5a to produce an estimated grams CO_2/gasoline gallon equivalent for fuel-cell vehicles of 3,816 grams, which was then used to estimate emissions from hydrogen fuel-cell vehicles manufactured to comply with the Cleaner Cars Sales Goals program. (Fuel-cycle emissions from hydrogen fuel-cell vehicles were used in lieu of direct tailpipe emissions since fuel-cell vehicles emit no pollution from the tailpipe and it was assumed that the hydrogen fuel —and its associated emissions—would be created within Maine.)

For the global warming gas emission standards, we assumed percentage reductions in per-mile vehicle emissions as described in 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.

Cleaner Cars Sales Goals Program Implementation

In calculating emission reductions resulting from the Cleaner Cars Sales Goals program, we assumed implementation of

the program beginning in model year 2009 with the same requirements as the California program. Vehicles meeting the AT-PZEV standards were assumed to be "Type D" Hybrids (similar to the Toyota Prius), while vehicles meeting pure ZEV standards were assumed to be hydrogen fuel-cell vehicles whose fuel was produced from natural gas.

Percentages of vehicles meeting PZEV, AT-PZEV and ZEV criteria were estimated in the following manner:

- Light-duty vehicle sales in Maine for each category (cars and light trucks) were estimated based on year 2003 new vehicle registration figures from Alliance of Automobile Manufacturers, *Light Truck Country*, downloaded from autoalliance.org/archives/000141.html, 27 August 2004, with the light truck category divided into heavy and light light-duty trucks using EPA fleet composition estimates as described above. These figures were then multiplied by the percentage of sales subject to the Cleaner Cars Sales Goals for each year.
- This number was multiplied by 0.9 to account for the six-year time lag in calculating the sales base subject to the Cleaner Cars Sales Goals. (For example, a manufacturer's requirements in the 2009 through 2011 model years are based on percentages of sales during model years 2003 through 2005.)
- Where necessary, these values were multiplied by the percentage of vehicles supplied by major manufacturers versus all manufacturers as calculated from Ward's Communications, *2003 Ward's Automotive Yearbook*, 233. (Non-major manufacturers may comply with the entire Cleaner Cars Sales Goals program requirement by supplying PZEVs.)
- This value was then multiplied by the percentage sales requirement to arrive at the number of Cleaner Cars Sales Goals program credits that would need to be accumulated in each model year.
- The credit requirement was divided by the number of credits received by each vehicle supplied as described in California Environmental Protection Agency, Air Resources Board, *Final Regulation Order: The 2003 Amendments to the California Zero Emission Vehicle Regulation*, 9 January 2004.
- The resulting number of vehicles was then divided by total light-duty vehicle sales to arrive at the percentage of sales required of each vehicle type.
- No pure ZEVs were assumed to be required for sale in Maine until the 2012 model year. For the 2012 through 2017 model years, in which the pure ZEV requirement is based on a specific number of California sales, we divided the annual pure ZEV requirement in the California regulations by the number of new vehicles registered in California in 2001 per Ward's Communications, *2002 Ward's Automotive Yearbook*, 272. We assumed that the same percentage would apply to vehicle sales in Maine.

It was assumed that manufacturers would comply with ZEV and AT-PZEV requirements through the sale of fuel-cell and hybrid passenger cars. While heavier light trucks are also covered by the Cleaner Cars Sales Goals program, manufacturers have the flexibility to use credits accumulated from the sale of cars to achieve the light-truck requirement. Percentages of various vehicle types assumed to be required under the Cleaner Cars Sales Goals program are depicted in Fig. 7, page 20. (assuming a roughly 60/40 percentage split between light-truck sales and car sales throughout the entire period).

Fleet Emissions Projections

Based on the above data, three scenarios were created: a "Base Case" scenario based on projected trends in vehicle fuel economy, VMT and vehicle mix; a "Cleaner Cars Sales Goals Program" scenario based on the implementation scenario described above; and a "Global Warming Emission Standards" scenario based on the percentage emission reductions proposed by the CARB staff in August 2004. Each scenario began with data from 2000 and continued through 2020.

Projected emissions were based on the year-to-year increase (or decrease) in emissions derived from the estimation techniques described above. These year-to-year changes were then applied to the 2000 baseline emission level to create projections through 2020.

Other Assumptions

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

- **Rebound effects** – Research has shown that improved vehicle fuel economy often results in an increase in vehicle-miles traveled. By reducing the marginal cost of driving, fuel economy standards and other 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.[68] To account for this effect, carbon dioxide reductions in each of the scenarios were discounted by 20 percent. This estimate is likely quite conservative: in its own analysis using California-specific income and transportation data, CARB estimated a rebound effect ranging from 7 percent to less than 1 percent.[69]
- **Mix shifting** – We assumed that neither of the policies under study would result in changes in the class of vehicles purchased by Maine 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 Cleaner Cars Sales Goals or 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.

Comparison With Other Published Estimates

Over the past year, several estimates of the benefits of the Cleaner Cars Sales Goals program and global warming gas emission standards have been made. The estimates and projections in this report generally comport with those published elsewhere, with several minor exceptions.

- **Cleaner Cars Sales Goals program** The emission reductions from the Cleaner Cars Sales Goals program estimated here (0.027 MMTCE by 2020) are about 40 percent lower than the reductions estimated in the National Association of State PIRGs and Natural Resources Council of Maine's 2004 report, *A Blueprint for Action*. This is likely due to more conservative assumptions about the relative carbon dioxide emission reductions assumed to result from hybrid-electric and fuel-cell vehicles and a delay in the assumed date of implementation to model year 2009.

- **Global warming emission standards** The emission reductions from the global warming emission standards estimated here (0.19 MMTCE by 2020) are approximately 19 percent greater than those estimated in *A Blueprint for Action*. The earlier report was produced prior to California's proposal for implementation of the standards and included very conservative assumptions about the outcome of the program. The estimate included in this report, however, is very close to the emission reductions assumed by the Maine greenhouse gas stakeholder process in its discussions of transportation and land-use measures to reduce global warming pollution.

Notes

1. Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report – Climate Change 2001: Summary for Policy Makers*, 2001.

2. Ibid.

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

4. Peter H. Gleick, et al., U.S. Global Change Research Program, *Report of the Water Sector Assessment Team of the National Assessment of the Potential Consequences of Climate Variability and Change*, September 2000, 71.

5. See note 3.

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

7. See note 3.

8. See notes 3 and 6.

9. See note 6.

10. Clean Air-Cool Planet, *Fact Sheet: Climate Change and the Northern Forest*, downloaded from www.cleanair-coolplanet.org/information/pdf/forest-factsheet.pdf, 4 August 2003; Vermont Maple Sugar Makers' Association, *Vermont Maple Facts*, downloaded from www.vermontmaple.org/mfacts.htm, 4 August 2003.

11. See notes 3 and 6.

12. Ibid.

13. Maine Department of Marine Resources, *Commercial Fisheries Landings: Preliminary 2002 Maine Landings by Value*, downloaded from www.maine.gov/dmr/commercialfishing/2002landingsbyvalue.htm, 17 June 2004. Shellfish include lobster, crab, mussels, clams, and scallops.

14. See notes 3 and 6.

15. Ibid.

16. Ibid.

17. Ibid.

18. Jennifer Weeks, Northeast States for Coordinated Air Use Management, *Draft Maine GHG Inventory, 1990-2000*, Powerpoint presentation to Maine greenhouse gas stakeholder process, 16 December 2003. The draft inventory notes that additional data are needed to more accurately estimate global warming emissions from waste disposal and wastewater treatment and suggests that additional review may be needed of emissions data from land use changes and forestry.

19. California Environmental Protection Agency, Air Resources Board, *Draft Staff Proposal Regarding the Maximum Feasible and Cost-Effective Reduction of Greenhouse Gas Emissions from Motor Vehicles*, 14 June 2004, 8.

20. U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2002*, 15 April 2004.

21. Based on data compiled for National Association of State PIRGs, Natural Resources Council of Maine, *A Blueprint for Action: Policy Options to Reduce Maine's Contribution to Global Warming*, Summer 2004.

22. See note 18.

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

24. Ibid.

25. Ibid.

26. VMT estimates and projections from Edward Hanscom, Bureau of Planning, Maine Department of Transportation, personal communication, 23 October 2003.

27. Ibid.

28. Stacy C. Davis, Susan W. Deigel, Center for Transportation Analysis, Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 22*, September 2002, Chapter 7. The federal government has approved an slight increase in light truck CAFE standards to take effect for the 2005 model year.

29. U.S. Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004*, Appendix C, April 2004. The federal law that established CAFE standards also established the means for testing of vehicles to determine compliance with the standards. It has long been recognized that these testing methods overstate the "real world" fuel economy of vehicles. EPA has begun to include adjusted figures in its reporting of fuel economy trends and, in its 2004 report, included an estimate of real-world vehicle mileage based on increases in the percentage of urban driving. In this report, all discussions of vehicle fuel economy will refer to "real world" efficiency levels rather than "EPA rated" levels. However, it should be noted that Maine, being a primarily rural state, may not experience the degree of fuel economy degradation experienced in the nation as a whole.

30. Ibid.

31. Real world fuel economy: U.S. Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004*, Appendix C, April 2004. CAFE standards: U.S. Department of Transportation, *Summary of Fuel Economy Performance*, March 2003.

32. See note 29.

33. Ibid.

34. U.S. Environmental Protection Agency, *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; MOBILE6 run conducted by MASSPIRG Education Fund based on national defaults, January 2003.

35. Based on comparison of values from National Association of State PIRGs and Natural Resources Council of Maine, *A Blueprint for Action: Policy Options to Reduce Maine's Contribution to Global Warming*, Summer 2004, with overall Maine global warming emissions from Jennifer Weeks, Northeast States for Coordinated Air Use Management, *Draft Maine GHG Inventory, 1990-2000*, Powerpoint presentation to Maine greenhouse gas stakeholder process, 16 December 2003.

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38. Coralie Cooper, Northeast States for Coordinated Air Use Management, *ZEV Program in the Northeast*, PowerPoint presentation, 7 April 2004.

39. State of California, Air Resources Board, *Resolution 03-4*, 24 April 2003.

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61. The reasons behind the lack of market success of the EV-Plus, EV1 and similar electric vehicles are complex, and may have much to do with automakers' failure to properly market their vehicles to the public.

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63. 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. Earlier analysis by CARB suggested that even deeper cuts in vehicle emissions could be made more quickly. CARB's initial draft proposal for implementation of the standards called for cost-effective emission reductions of 22 percent from cars and 24 percent from light trucks in the near term. Over the medium term (2012 to 2014), cost-effective reductions of 32 percent for cars and 30 percent for light-trucks were deemed feasible. In addition, the standards were assumed to be phased in much more quickly than under CARB's final initial proposal. See California Environmental Protection Agency, Air Resources Board, *Draft Staff Proposal Regarding the Maximum Feasible and Cost-Effective Reduction of Greenhouse Gas Emissions from Motor Vehicles*, 14 June 2004.

64. 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; California Environmental Protection Agency, Air Resources Board, *Addendum Presenting and Describing Revisions to: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles*, 10 September 2004.

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69. See note 63.

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