Cars and Global Warming

Policy Options to Reduce Washington's Global Warming Pollution from Cars and Light Trucks

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March 2005

ACKNOWLEDGMENTS

The authors wish to acknowledge Patrick Mazza of Climate Solutions and Clark Williams-Derry of Northwest Environment Watch for providing editorial review.

Sincere thanks to the Energy Foundation for providing financial support for this project.

The authors alone bear responsibility for any factual errors. The recommendations are those of the Washington Public Interest Research Group Foundation. The views expressed in this report are those of the authors and do not necessarily reflect the views of those who provided editorial or technical review.

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Cover photo: Sandy Ridlington

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EXECUTIVE SUMMARY

Washington could significantly limit its contribution to glo bal warming over the next two decades by adopting the Clean Cars program to reduce carbon dioxide emissions from cars and light trucks.

Global warming poses a serious threat to Washington's future. Scientists project that average temperatures in Washington could increase by 2° to 9° F over the next century if no action is taken to reduce emissions of global warming pollution—potentially leading to coastal flooding, significantly decreased snowpack, increased air pollution and heat-related deaths, and a host of other impacts on Washington's environment, public health and economy (p. 7).

Controlling global warming pollution from the transportation sector—and particularly cars and light trucks—will be an essential part of Washington's strategy for reducing global warming emissions.

The transportation sector is responsible for 52 percent of Washington's 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 pollution in the transportation sector, responsible for nearly half of all transportation sector emissions and about one-fifth of Washington's total emissions of global warming pollution (p. 9).

Carbon dioxide pollution from cars and light trucks in Washington is likely to increase by approximately 55 percent over 1990 levels by 2020 unless action is taken to reduce emissions.

- Carbon dioxide emissions from the Washington light-duty vehicle fleet are projected to experience a 13 percent increase over 2000 levels by 2010, followed by a further 17 percent increase between 2010 and 2020 (p. 13-14).
- 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 light trucks, including SUVs, and increasing vehicle travel have put Washington on a course toward dramatically increased emissions of carbon dioxide from transportation over the next two decades.

Adopting the Clean Cars program—with its Low-Emission Vehicle (LEV II) program and the vehicle global warming pollution standards—would be an important step to reducing greenhouse gas pollution from cars and trucks.

- The LEV II program will pave the way for the widespread introduction of clean, advanced technology vehicles (such as hybrid-electric vehicles) that could result in dramatic, long-term reductions in carbon emissions. In the process, it will lead to light-duty carbon dioxide emission reductions of about 1.3 percent below projected levels by 2020 (p. 19).
- Vehicle global warming pollution standards (also known as the "Pavley" standards for their original legislative sponsor in California) could produce significant reductions in vehicle carbon dioxide emissions as cars are equipped with direct-injection engines, advanced transmissions, improved air conditioning systems, and other advanced technologies. These improvements could reduce emissions from new cars by 30 percent by 2016. If Washington were to implement the program beginning in 2008 (when

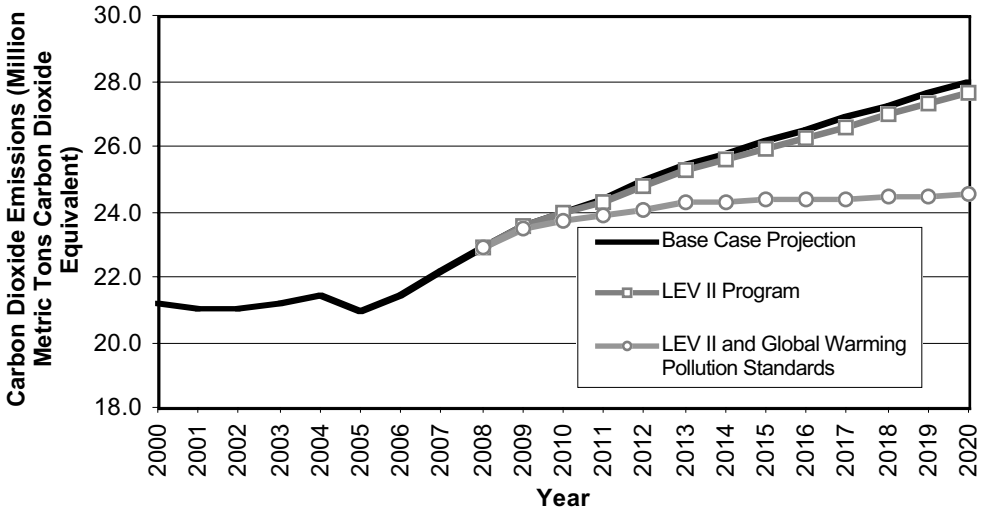
model year 2009 vehicles go on sale), it could reduce carbon dioxide pollution from the car and light truck fleet by about 12 percent below projected levels by 2020. Savings will continue to increase in later years as older vehicles are replaced with ones that comply with the new emissions standard (p. 20-21).

- Increased equipment costs will be offset by reduced operating costs so that the purchaser of a new car is projected to save $3 per month in 2016 when the standards are fully phased in. Buyers of light trucks will save even more (p. 21).
- Even with implementation of both components of the Clean Cars program, carbon dioxide emissions from cars and light trucks in 2020 would be significantly higher than pollution in 2000 because of a large projected increase in vehicle travel. Thus, Washington will need to adopt additional policies to reduce emissions from the transportation sector if it wishes to stabilize and reduce global warming pollution (p. 21).

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

- Washington should adopt the Clean Car standards as a first step to reducing emissions of carbon dioxide.
- The state should also commit to implementing these standards in 2005 so that they will take effect as soon as possible, which is in model year 2009.

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



INTRODUCTION

Global warming and its consequences will change Washington's environment and economy. Warmer temperatures may lead to earlier snowmelts and decreased snowpack, increased summer drought, shifts in forest cover, higher sea levels, and myriad other effects.

Addressing emissions of global warming gases from the transportation sector is Washington's biggest challenge to meeting its emission reduction goals, not only because transportation is the largest source of the state's global warming pollution but also because emissions from the transportation sector may become a larger share of total pollution in coming years.

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 reducing the state's pollution in the long term.

A transportation policy Washington could adopt is the Clean Cars program, which has two components: the LEV II program and vehicle emission standards for global warming gases.

The LEV II program, which originated in California but has been adopted by other states including New York, New Jersey and Massachusetts, would require that a percentage of vehicles sold in Washington in coming years be advanced-technology vehicles such as hybrids, which have lower global warming emissions.

Vehicle global warming pollution standards, which also originated in California, would require automakers to reduce emissions of global warming pollutants by incorporating direct-injection engines, continuously variable transmissions, improved air conditioners, and other advanced technologies into new vehicles. These standards will lead to even greater progress toward realizing the promise of new technologies to reduce the impact of our transportation system on the climate.

This report documents the benefit Washington may receive from adopting the Clean Cars program. But it also documents the challenge the state faces in reining in emissions from the transportation sector. Even with adoption of the program, Washington will still need to take additional steps to curtail global warming pollution from transportation and protect the climate.

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 will have serious repercussions for Washington.

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, and the total concentration of carbon dioxide is at its highest point in 420,000 years.[1] Concentrations of other global warming gases—such as methane and nitrous oxide—have increased as well.

As a result, average global temperatures increased during the 20th century by about 1° F. And, if current trends in global warming pollution 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 Washington 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 Ellensburg has increased by 1° F.[3] Meanwhile, precipitation has increased by 20 percent in parts of the state, especially in western Washington.

Should current emission trends continue, mid-range projections show temperatures in Washington could increase by 5° F in winter and summer and by 4° F in spring and fall by 2100, with a possible range of 2° F to 9° F. The number of extremely hot summer days would increase. Precipitation levels also could change. Scientific models suggest precipitation may increase by 10 percent, particularly in winter.

In any event, the impacts of such a shift in average temperature and precipitation would be severe. One of the most serious consequences for Washington would be a smaller mountain snowpack that would also melt earlier in the year. This would result in higher streamflows in the spring and significantly lower river levels in the late summer and fall, when the water is needed most for hydroelectric power generation, irrigation, river transportation, and salmon migration. By 2050, annual snowpack could be reduced by 50 percent.[4]

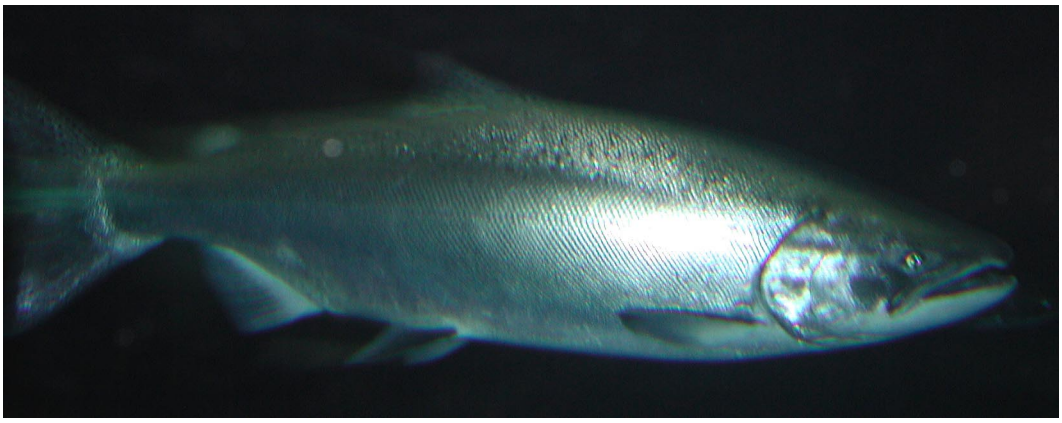
Among other potential impacts:

- 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.
- Increased risk of heat-related illnesses and deaths—perhaps a tripling of heat-related deaths.
- Increased coastal flooding due to higher sea levels, with sea levels projected to rise as much as 19 inches along the Washington coast by 2100. This could cause the loss of half of Puget Sound's remaining tidal flats, which are important for shellfish and wildfowl populations.
- Reduced areas for skiing, hurting the ski industry.
- Increased evaporation from streams and lakes, resulting in lower water levels and reduced water quality. Groundwater supplies could be affected also.
- Loss of all habitat for pink and chum salmon, and much of the habitat of brown and brook trout. Some studies project that warmer ocean temperatures could force ocean-dwelling salmon from the Pacific north into the Bering Sea, requiring them to migrate farther and reducing their reproductive success.[5]
- Declines of as much as 25 percent in the amount of forested area, drier forests more prone to wildfires, and reduced timber harvests.

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 Washington's environment, economy and public health—unless immediate action is taken to limit our emissions of global warming pollutants such as carbon dioxide.

Global Warming Pollution in Washington

Based on an inventory compiled for the Department of Community, Trade, and Economic Development, emissions of global warming pollution in Washington increased by nearly 10 percent between 1990 and 2000, to approximately 99 million metric tons of carbon dioxide equivalent (MMTCO2E, see note on units below).[6] Of those emissions, about 80 percent were in the form of carbon dioxide released as a result of the combustion of fossil fuels.



Global warming may cause more habitat loss of already endangered salmon.

The transportation sector is responsible for approximately 45 percent of Washington's contribution to global warming and 52 percent of its releases of carbon dioxide.[10] (See Figure 1.) Cars and light trucks—such as pickups, minivans and SUVs—are the most significant sources of global warming pollution within the transportation sector, responsible for 47 percent of all transportation-sector emissions and about one-fifth of Washington's total emissions of global warming pollution.[11]

Washington's Climate Change Reduction Efforts

Recognizing the serious consequences of global warming, Washington has begun to consider how to reduce its global warming emissions.

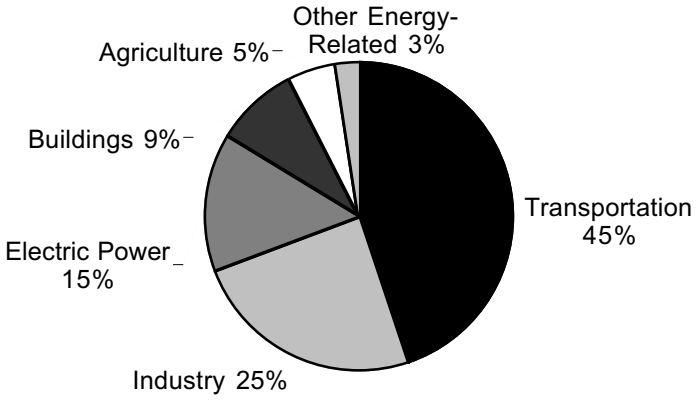
In 2003, the governors of Washington, Oregon and California created the West Coast Governors' Global Warming Initiative, in which the states pledged to reduce global warming pollution.[13] The governors have approved 36 recommendations for action, including:

- Setting goals for improving state vehicle fleet global warming emissions.
- Creating a network of truck stops that will allow truckers to shut off their engines during rest breaks but continue to receive heat and power in their vehicles.
- Adopting energy efficiency standards for 8 to 14 types of appliances.
- Improving building energy codes to reduce energy use by at least 15 percent cumulatively by 2015.

However, the governors have not yet established concrete regional or statewide emission reductions targets that would help spur action on the approved recommendations or other policies, and that would provide a benchmark for measuring progress.

The Puget Sound Clean Air Agency, which manages air quality programs for King, Kitsap, Pierce and Snohomish counties, has undertaken its own global warming emission reduction plan. It convened a group of stakeholders—representatives from business, government, and the nonprofit sector—to develop policies to help the Puget Sound area reduce its global warming pollution.

Figure 1. Washington Sources of Global Warming Pollution in 2000 from In-State Activity[12]



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 pollution typically use units that communicate emissions in terms of their global warming potential.

In this report, we use units of "carbon dioxide equivalent." Other documents communicate pollution in terms 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. To translate the carbon dioxide equivalent to carbon equivalent, one can simply multiply by 0.2727.

Other Global Warming Pollutants

While 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 pollution that must be considered in any emission reduction strategy.

• **Methane** – Methane gas is likely the second-most important contributor to global warming. Cars and light trucks produce methane in their exhaust, but it is thought that they are only minor emitters of methane and that their pollution will be reduced in the future through improved emission control systems.[7]

• **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.[8] As with methane emissions, improved pollution 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. Some 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 pollution contributes to global warming.[9]

In December 2004, the group released recommendations for cutting emissions from all uses of energy, including transportation, buildings and facilities, electricity generation, and land use. Among its key recommendations were adopting both the LEV II program and the vehicle global warming pollution standards included in the Clean Cars program, reducing the growth in vehicle miles traveled, promoting renewable energy, increasing energy efficiency in buildings, reducing waste and increasing recycling, and protecting natural spaces. The group also urged the creation and adoption of specific pollution reduction targets as part of a comprehensive plan for reducing emissions.

Separately, the city of Seattle has established a goal of reducing its global warming pollution by 7 to 40 percent below 1990 levels by 2010.[14] Further, Washington's former Attorney General (and now governor) Christine Gregoire joined 10 other states in a lawsuit against the U.S. EPA for failing to regulate global warming pollution.[15]

The Transportation Challenge

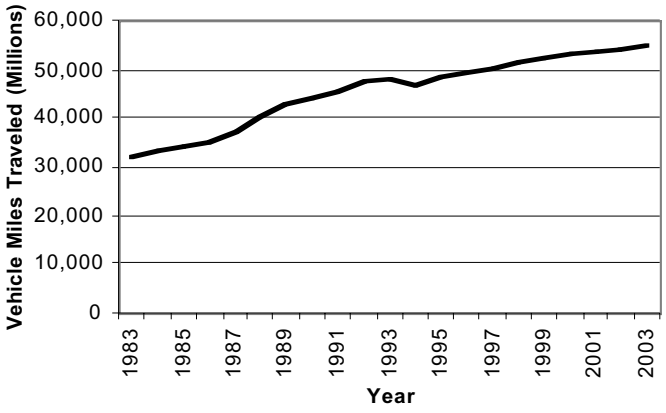
In spite of Washington's recent steps to reduce emissions of global warming pollution, more must be done. The challenge of reducing global warming pollu-

tion from cars and trucks is formidable, and three trends in the transportation sector make this goal more challenging with each passing year: increasing vehicle miles traveled, stagnating fuel economy, and an increasing number of SUVs and light trucks.

Increasing Vehicle Miles Traveled

Washington residents are traveling more miles in their cars and light trucks than ever before. Between 1983 and 2003, the number of vehicle-miles traveled (VMT) annually on Washington highways increased from 32 billion miles to 55 billion miles—an increase of 70 percent.[16] (See Figure 2.)

Figure 2. Washington VMT Increased More than 70 Percent between 1983 and 2003[17]



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.[18] (The National Highway Traffic Safety Administration recently increased the light truck stan-

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 amount of energy).

Unlike other vehicular air pollutants that result from the incomplete combustion of fossil fuels or from fuel impurities—and which can be reduced by using better engine technologies—carbon dioxide is an unavoidable byproduct when fossil fuels are burned. As a result, there are three main ways to limit carbon dioxide pollution from motor vehicles:

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

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.

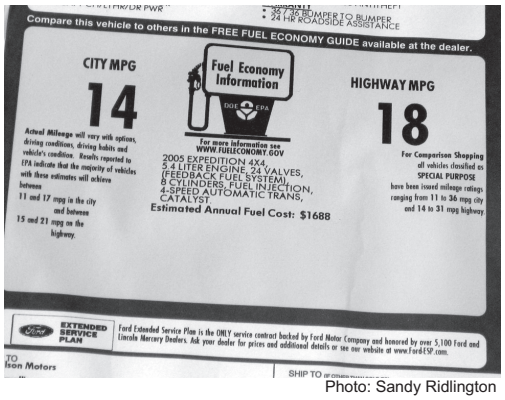


Photo: Sandy Ridlington

The low fuel economy of SUVs has contributed to a declining fleet-average fuel economy level.

dard to 22.2 mpg, to be achieved by model year 2007.)

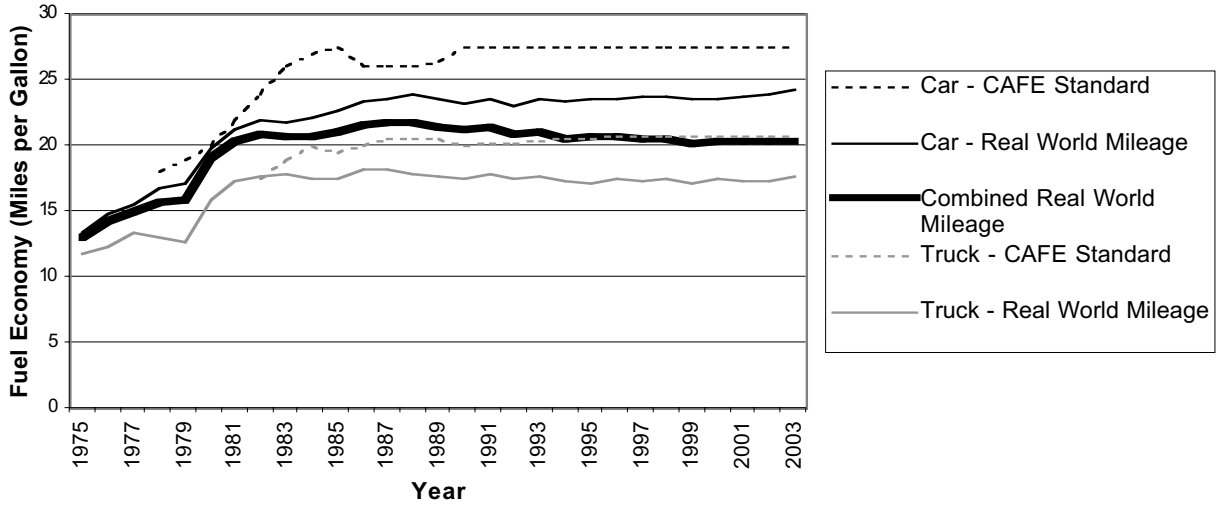
In the decade-and-a-half following enactment of the CAFE standards, the "real world" fuel economy of passenger cars nearly doubled—from 13.4 mpg in 1975 to 24.0 mpg in 1988. Similarly, light trucks experienced an increase in real-world fuel economy from 11.8 mpg in 1975 to 18.3 mpg in 1987.[19]

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-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.[20] (See Figure 3.)

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 pollution.

Figure 3. Average Fuel Economy for New Light-Duty Vehicle Fleet on the Decline[21]



Growing Numbers of 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 pick-up 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.[22] (See Figure 4a-4c.)

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.[23]

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.[24]

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 Washington policy-makers as they attempt to reduce global warming pollution from the transportation sector.

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

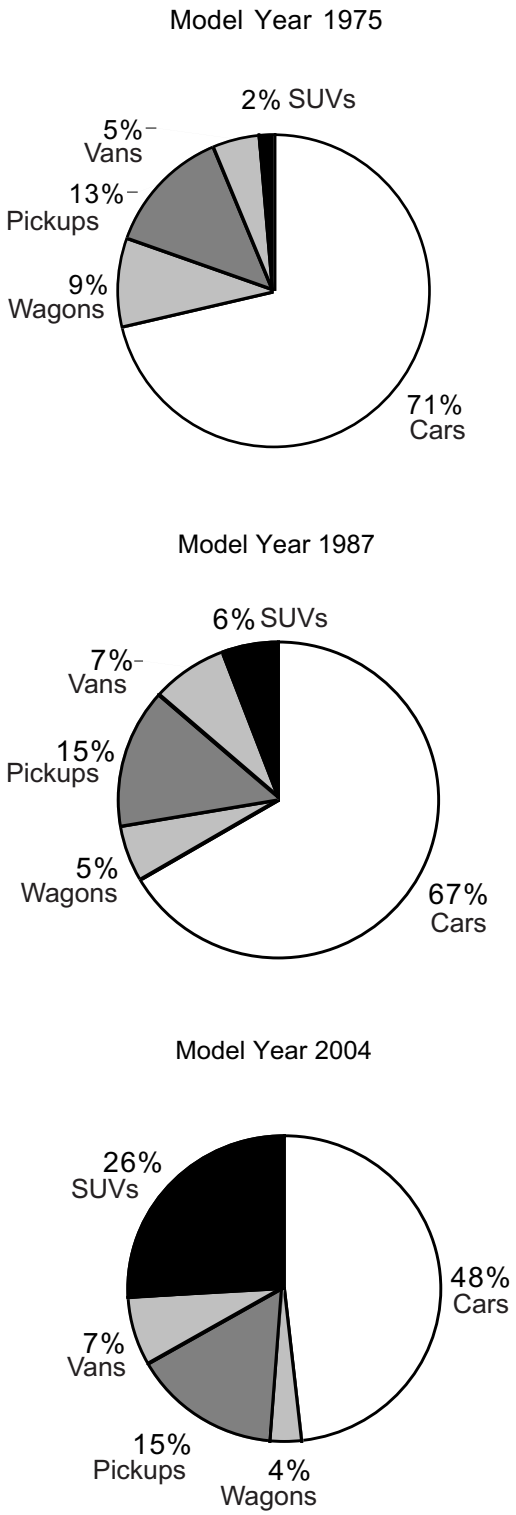


Photo: Sandy Ridlington

Increasing numbers of SUVs and pickup trucks have added to Washington's global warming pollution.

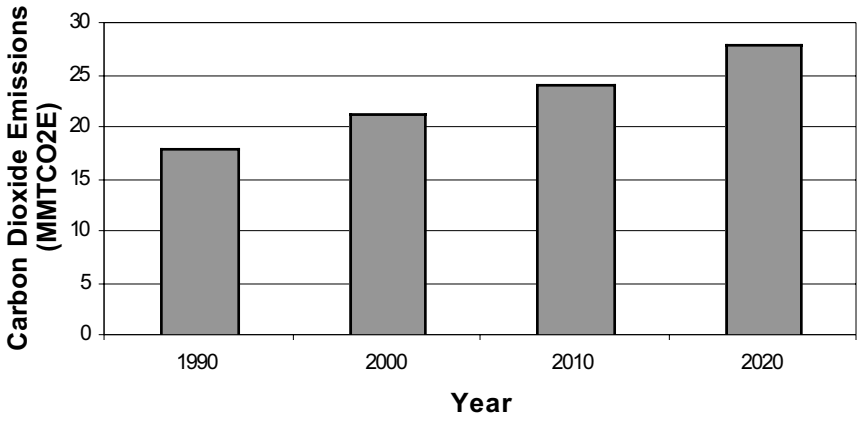
Vehicle Carbon Dioxide Pollution in Washington: Past and Future

Based on Washington-specific fuel consumption data compiled by the U.S. Energy Information Administration (EIA), cars and light-duty trucks released approximately 18.1 million metric tons carbon dioxide equivalent (MMTCO2E) of carbon dioxide into the atmosphere in 1990. By 2000, those emissions had increased by about 17 percent, to 21.2 MMTCO2E—meaning that cars and trucks were responsible for approximately one-fifth of Washington's contribution to global warming in 2000.[25] (Cars and light trucks are responsible for nearly half of transportation sector carbon dioxide emissions, which is responsible for just over half of all carbon dioxide emissions. Carbon dioxide accounts for roughly 90 percent of Washington's global warming emissions.)

Any attempt to project Washington's future global warming pollution 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.

Based on these assumptions, carbon dioxide emissions from the Washington light-duty vehicle fleet are projected to

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



experience a 13 percent increase over 2000 levels by 2010, followed by a further 17 percent increase between 2010 and 2020. In other words, by 2020, carbon dioxide emissions from cars and light trucks will exceed 1990 levels by 55 percent in the absence of action to reduce emissions. (See Figure 5.) (Though Washington has not yet established emission reduction targets, 1990 is a common benchmark year in other states' programs and thus we use it here as a reference point.)

An increase of such magnitude would severely challenge Washington's ability to stabilize and reduce its global warming emissions.

However, this path toward increasing carbon dioxide pollution 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 Washington's future emissions of global warming pollution while potentially saving money for drivers. One of the most powerful policy options is California's Clean Cars program.

Tools to Reduce Global Warming Pollution from Cars and Light Trucks

Washington has many potential tools available to reduce emissions of global warming pollution from the transportation sector. Among the most powerful of those tools is the Clean Cars program, with its LEV II program and global warming pollution standards for cars and trucks.

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 standards implemented by the state of California, the only state empowered by the Clean Air Act to devise its own emission regulations.

Washington could follow the lead of seven other states—Vermont, New York, New Jersey, Massachusetts, Connecticut, Rhode Island and California—that have adopted or are in the process of adopting the LEV II program. Though the program targets smog-forming chemicals and other pollutants, the program likely will lower emissions of global warming gases also.

Washington and other states also have the opportunity to adopt standards limiting global warming pollution from cars and light trucks. The standards will bring about significant reductions in carbon dioxide emissions from cars and light trucks over the next decade.

Adopting the Clean Cars program, with both its LEV II program and vehicle global warming pollution standards, is an important step in Washington's efforts to reduce the state's global warming emissions.

LEV II Program

The LEV II program seeks to reduce emissions of smog-forming and other hazardous pollutants. It achieves its goals by establishing fleet-wide limits on tailpipe emissions and by requiring the sale of advanced-technology vehicles such as hybrids that have even lower emissions. Eventually, the program calls for the sale of zero-emission vehicles (ZEVs). It is likely, however, that some of the technological changes encouraged by the LEV II program will reduce emissions of global warming pollutants as well.

By adopting the program, Washington can lay the groundwork to have increasing percentages of advanced-technology vehicles on the road 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 toxic or smog-forming pollutants from their tailpipes or on-board fuel systems. They also have the potential to release far fewer global warming gases than today's vehicles.

The most recent revision to the LEV II 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. As a result, automakers would not have to sell fuel-cell or other pure zero-emission vehicles in Washington until at least model year 2012. Even then, the number of pure ZEVs required for sale in Washington would be small, representing less than 1 percent of new car and light truck sales until model year 2016.[26]

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.[27]

The current incarnation of the LEV II 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. (Note that fuel-cell vehicles have zero emissions provided that the electricity that is used to create the hydrogen is generated from renewable sources.)

Partial Zero-Emission Vehicles (PZEVs)

The majority of vehicles that automakers produce to comply with the LEV II program 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.[28]

While PZEVs will play an important role in helping Washington to achieve its air quality goals, the technologies used in PZEVs do not necessarily make a substantial contribution to reducing global warming pollution 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 LEV II 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 sales 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 85,000 hybrids were sold in the U.S. in 2004, an increase of 63 percent from the previous year.[29]

Thus far, there are four models of vehicles that have been certified to AT-PZEV emission standards: the hybrid Toyota Prius, Honda Civic, and Ford Escape, and the natural gas-powered Honda Civic GX.[30] (Several other hybrid vehicles, such as the Honda Accord, are on the market but their emissions of toxic air pollutants are too high to meet AT-PZEV standards. These vehicles nonetheless achieve measurable reductions in global warming emissions.) Unfortunately, although a healthy market for hybrids appears to exist, automakers have not yet supplied hybrids in large enough quantities to meet consumer demand. 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 Nissan Altima and Toyota Highlander—that could qualify for AT-PZEV credit.[31]

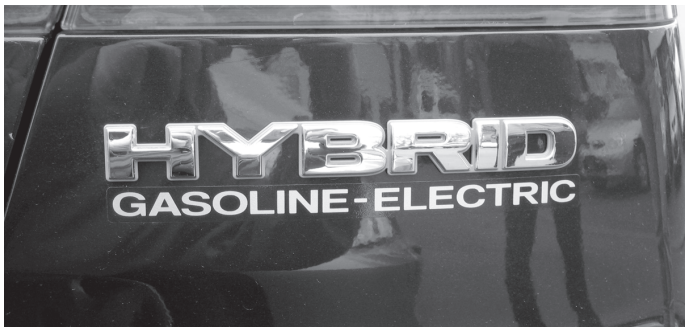


Photo: Sandy Ridlington

Sales of hybrid-electric vehicles, which have lower global warming emissions, will increase under the LEV II program.

Should automakers choose to maximize their use of AT-PZEVs to comply with the LEV II portion of the Clean Cars program—and do so using vehicles similar to the Toyota Prius—hybrids could make up about 3.5 percent of car and light truck sales in 2008, increasing to 7 percent by 2012. (See Figure 6.) This translates to sales of about 12,000 hybrids in Washington in 2008, increasing to approximately 23,000 annually by 2016. Because the LEV II 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, which would reduce the global warming benefits of the program.

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 pollution. Some, like the Toyota Prius, have relatively low global warming emissions. Others, such as hybrid pickup trucks to be sold by General Motors and DaimlerChrysler, continue to have significant global warming pollution despite their improved emissions compared to conventional models. The LEV II 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 pollution. 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.[32]

LEV II Program Impacts: Long Term

On the front end, no assessment of short-term global warming pollution reductions can precisely capture the poten-

Figure 6. LEV II Percentage of Light-Duty Vehicle Sales, 2008 through 2020

tial long-term and indirect benefits of the LEV II program in reducing carbon dioxide emissions. At its heart, the program is a technology acceleration program—one that attempts to jumpstart 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 pollution reductions as technological changes brought about by the program spread to other vehicles in the Washington 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 LEV program 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's 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 hundreds of thousands of vehicles worldwide and have laid the groundwork for recent advances in fuel-cell vehicle technology.[33]

Similarly, the current form of the LEV II 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 here.

LEV II Program Impacts: Short Term

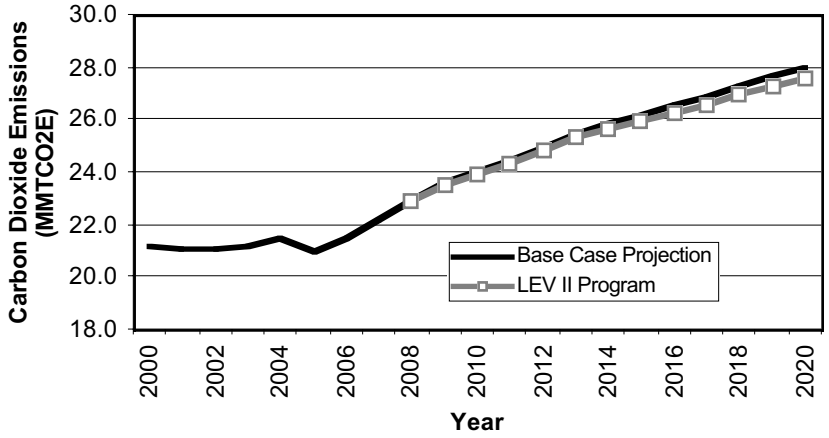
The short-term impact of the LEV II program on carbon dioxide emissions in Washington will largely be determined by how automakers choose to comply with the program's flexible provisions. There are almost infinite options available to automakers for compliance—however, it is likely that one or several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

We assume that automakers will take maximum advantage of the ability to meet LEV II 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 Washington beginning in the 2009 model year would reduce light-duty vehicle carbon dioxide emissions by about 1.3 percent versus base case projections by 2020—for a total reduction in emissions of about 0.37 MMTCO2E. (See Figure 7.)

Washington's adoption of the LEV II program could result in reduced global warming and toxic pollution from vehicles as more hybrids are sold. Equally important, adopting the LEV II program is necessary if Washington wants to adopt the other portion of the Clean Cars program—vehicle global warming pollution standards—which will provide even greater emission reductions.

Figure 7. Projected Reductions in Carbon Dioxide Emissions Under the LEV II Program (Light-Duty Vehicles)



Vehicle Global Warming Pollution Standards

In July 2002, California adopted 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. Emissions of global warming pollution will fall and consumers will likely save money.[34]

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.[35]

In September 2004, CARB adopted rules for implementation of the global warming pollution standards. As required by the initial legislation, CARB has submitted the regulations to the California Legislature for review during 2005. Those proposed rules provided the basis of our analysis here.

In developing the global warming pollution 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 pollution from vehicles. CARB's proposal estimates that near-term technologies could reduce average global warming pollution 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.[36] On average, CARB expects emissions from new cars, light trucks, and SUVs to be 30 percent lower by 2016.[37]

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 pollution required by 2016 would cost an average of $1,064 more for consumers,

while light trucks achieving the required 25 percent reduction would cost about $1,029 more.[38]

However, the agency also estimates that the rules will significantly reduce operating costs for new vehicles. Though consumers will face higher monthly loan payments when purchasing vehicles that comply with the standards, those increased costs will be more than offset by lower operating expenses. For example, a consumer who buys a new car in 2016 will pay $20 more per month on the car loan but will save $23 per month in operating expenses, for a total savings of $3 per month. After the loan is paid off, the consumer will save the full $23 per month. Drivers who purchase a light truck or who pay for the vehicle in cash will experience greater savings.[39] CARB also projects that the net impact of the standards to the state's economy will be positive, suggesting that ***Washington could save money while at the same time reducing the state's overall emissions of global warming gases.***[40]

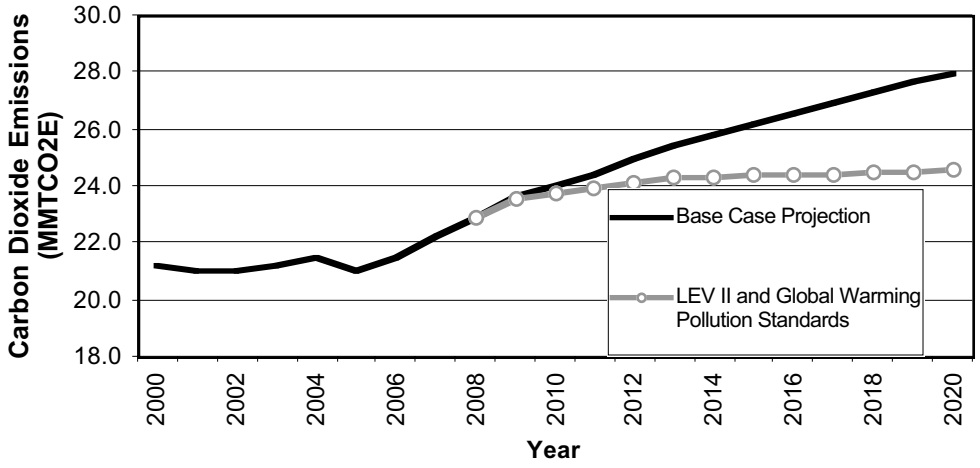
Assuming that the September 2004 version of the global warming pollution standards is adopted as proposed, were Washington to implement those standards beginning with the 2009 model year the resulting reductions in global warming pollution would be significant. Compared to the base case projection, the emission standards would reduce light-duty carbon dioxide emissions by 12 percent by 2020—for a total reduction of 3.4 MMTCO2E. (See Figure 8.) Carbon dioxide emissions will continue to fall after 2020 as older vehicles that were manufactured before 2009 are replaced with newer vehicles.

The Need for Additional Actions

Implementing the Clean Cars program can contribute significantly to Washington's efforts to reduce global warming pollution from the transportation sector. With both components of the program in effect, emissions from light-duty cars and trucks would be 16 percent greater in 2020 than they were in 2000, compared to 32 percent greater if no action is taken.

Thus, though it can yield significant progress and would be a major step forward, adopting the Clean Cars program would not be enough to reduce Washington's global warming emissions.

Figure 8. Reductions in Carbon Dioxide Emissions Under Vehicle Global Warming Pollution Standards (Light-Duty Vehicles)



A number of other policy options exist for Washington to reduce its emissions, including:

- Incentives for individuals and fleets to purchase vehicles with lower carbon emissions. One possible approach is to offer "feebates," which would give a rebate to car buyers who purchase vehicles that emit less global warming pollution. The rebate could be funded by a fee on purchasers of less efficient vehicles and thus could be revenue neutral for the state.
- "Pay-as-you-drive" insurance, which can be offered by private insurers and allows drivers to purchase vehicle insurance by the mile. Such a program makes drivers more aware of the full costs of each mile driven and can reduce excessive driving.
- Improved transit service, which can reduce the amount citizens need to drive.
- Smart growth, which places shops, offices, and homes within walking distance, or makes them accessible by transit.

The federal government also could assist Washington's efforts to reduce global warming pollution by increasing the federal corporate average fuel economy (CAFE) standard.[41]

POLICY FINDINGS

To stabilize and reduce its global warming pollution to protect the climate, Washington will need to make significant emissions reductions from light-duty vehicles.

To achieve this goal:

- The state should adopt the Clean Cars program so that it will take effect in 2008 (which is when 2009 model year vehicles will go on sale).
- Washington should take aggressive action to reduce transportation-sector global warming pollution, including actions that speed the deployment of environmentally preferable advanced-technology vehicles (such as hybrids) and reduce the rate of growth in vehicle travel.

ASSUMPTIONS AND METHODOLOGY

Projections of future global warming pollution from automobiles depend a great deal on the assumptions used. This section details the assumptions we made about future trends and explains the methodology we used to estimate the impact of various programs.

Baseline Light-Duty Vehicle Carbon Dioxide Emissions

Carbon dioxide emissions from light-duty vehicles (cars and light trucks) in Washington 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, 7 December 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 Washington were obtained from Brian Calkins, Transportation Economist, Washington State Department of Transportation, *Forecast of Fuels, Vehicles, and Related Data Through 2031*, November 2004.

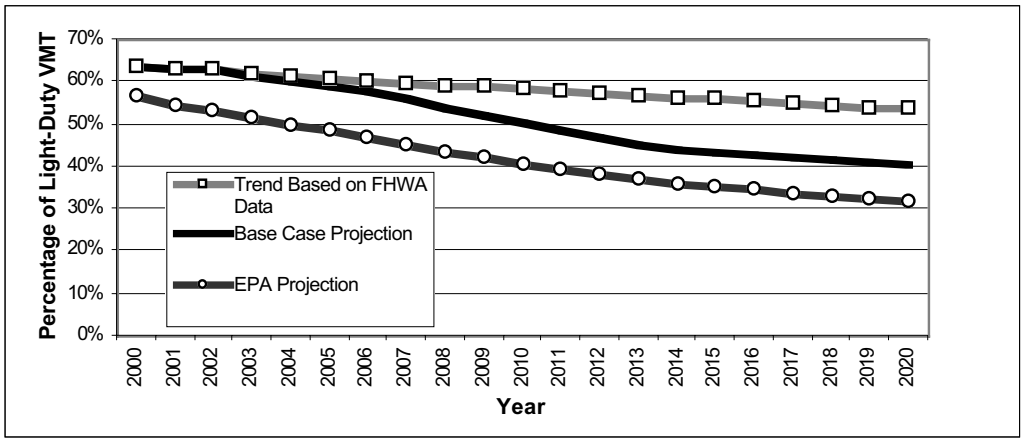
VMT Percentages by Vehicle Type

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 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. (Washington-specific data on VMT splits are unavailable but the state has a higher ratio of registered cars to trucks than the national average, according to Federal Highway Administration, *Highway Statistics 2002*, October 2003, Table MV-1. This may cause our analysis to undercount to the program's benefits because per-mile emissions reductions for cars are greater than for trucks and total emissions reductions are undercounted in Washington by using national figures for car and light truck VMT.)

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

Figure 9. Percentage of Light-Duty Vehicle-Miles Traveled in Cars



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 Figure 9.)

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 0.84 for years 2000 through 2020, based on the ratio of revised mpg to lab tested mpg as reported by EPA, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975-2004,* April 2004. (The degradation factor represents the degree to which real-world fuel economy falls below that reported as a result of EPA testing.)

For hybrid-electric vehicles used to comply with AT-PZEV requirements, fuel economy was estimated to exceed that of conventional vehicles by 30 percent, per National Research Council, National Academy of Engineering, *The*

Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs, the National Academies Press, 2004. This same document provided the assumption that hydrogen fuel-cell vehicles would achieve 58 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 LEV II 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 Washington.)

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.

LEV II Program Implementation

In calculating emission reductions resulting from the LEV II 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 Washington 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 LEV II program 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 LEV II program. (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 LEV II program requirement by supplying PZEVs.)
- This value was then multiplied by the percentage sales requirement to arrive at the number of LEV II 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 Cali-

fornia 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 Washington 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 Washington.

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 LEV II 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 LEV II program are depicted in Figure 6, page 18 (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 "LEV II program" scenario based on the implementation scenario described above; and a "Global Warming Pollution 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.[42] 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.[43]
- **Mix shifting** – We assumed that neither of the policies under study would result in changes in the class of vehicles purchased by Washington residents, or the relative amount that they are driven (rebound effect excluded). In addition, we assumed that the vehicle age distributions assumed by EPA re-

main 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.

NOTES

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

2. Ibid.

3. Data on the effects of global warming are from U.S. Environmental Protection Agency, *Global Warming-State Impacts: Washington*, Office of Policy, Planning, and Evaluation, September 1997, unless otherwise noted.

4. Patrick Mazza, Climate Solutions, *In Hot Water – A Snapshot of the Northwest's Changing Climate*, June 1999.

5. Ibid.

6. Jim Kerstetter, Washington State University Energy Cooperative, for the Washington Department of Community, Trade, and Economic Development, *Washington State's Greenhouse Gas Emissions: Sources and Trends*, June 2004.

7. 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.

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

9. James Hansen and Larissa Nazarenko, "Soot Climate Forcing Via Snow and Ice Albedos," *Proceedings of the National Academy of Sciences*, 101(2), 2004.

10. Jim Kerstetter, Washington State University Energy Cooperative, for the Department of Community, Trade, and Economic Development, *Washington State's Greenhouse Gas Emissions: Sources and Trends*, June 2004; breakdown of data in table 2 provided by Greg Nothstein, Department of Community, Trade, and Economic Development, personal communication, 24 January 2005.

11. Motor gasoline accounts for 51% of emissions from the transportation sector (Jim Kerstetter, Washington State University Energy Cooperative, for the Department of Community, Trade, and Economic Development, *Washington State's Greenhouse Gas Emissions: Sources and Trends*, June 2004). About 92 percent of motor gasoline use in the transportation sector is used to power light duty vehicles (EIA, *Supplemental Tables to Annual Energy Outlook 2003*).

12. Note that this data does not include the global warming emissions from electricity generated outside Washington but consumed in the state. Jim Kerstetter, Washington State University Energy Cooperative, for the Department of Community, Trade, and Economic Development, *Washington State's Greenhouse Gas Emissions: Sources and Trends*, June 2004; breakdown of data in table 2 provided by Greg Nothstein, Department of Community, Trade, and Economic Development, personal communication, 26 January 2005.

13. West Coast Governors' Global Warming Initiative, *Staff Recommendations to the Governors*, November 2004.

14. West Coast Governors' Global Warming Initiative, *Staff Recommendations to the Governors, Appendix I: Setting Global Warming Pollution Reduction Targets*, November 2004.

15. State Attorney General's Office, *State Challenges EPA Decision on Global Warming* (press release), 12 October 2003.

16. Brian Calkins, Transportation Economist, Washington State Department of Transportation, *Forecast of Fuels, Vehicles, and Related Data Through 2031*, November 2004.

17. Ibid.

18. Stacy C. Davis, Susan W. Deigel, Center for Transportation Analysis, Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 22*, September 2002, Chapter 7.

19. 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.

20. U.S. Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004*, Appendix C, April 2004.

21. 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.

22. See note 20.

23. Ibid.

24. U.S. Environmental Protection Agency, *Fleet Characterization Data for MOBILE6: Develop-*

ment 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.

25. Total emissions figure from Jim Kerstetter, Washington State University Energy Cooperative, for the Washington Department of Community, Trade, and Economic Development, *Washington State's Greenhouse Gas Emissions: Sources and Trends*, June 2004.

26. See "Assumptions and Methodology" for method of calculation.

27. California Environmental Protection Agency, Air Resources Board, *Resolution 03-4*, 24 April 2003.

28. California Environmental Protection Agency, Air Resources Board, *Cleaner Gas Cars*, downloaded from www.driveclean.ca.gov/en/gv/driveclean/vtype_cleaner.asp, 1 July 2004.

29. 2004 sales information based on announcements from Honda, Toyota, and Ford, which were the only manufacturers to sell significant numbers of hybrids in 2004. Toyota, *Toyota Reaches Two Million in Sales For The First Time in 47-Year History* (press release), 4 January 2005; Honda, *American Honda Sets New All-Time Sales Record* (press release), 4 January 2005; and Steve Geimann, *Bloomberg*, "Ford Expands Lineup of Gas-Electric Hybrid Vehicles (Update3)," 9 January 2005.

30. California Air Resources Board, *Clean Vehicle Search* results for hybrid-electric vehicles, downloaded from www.driveclean.ca.gov/en/gv/vsearch/cleansearch_result.asp?vehicletypeid=7, 1 July 2004; Ford Motor Company, *2005 Ford Escape Hybrid Launches*, 6 August 2004.

31. California Environmental Protection Agency, Air Resources Board, *Upcoming Clean Cars: Hybrids*, downloaded from www.driveclean.ca.gov/en/gv/vsearch/upcoming.asp, 17 January 2005.

32. Based on estimated fuel-efficiency improvement factor of 1.45 from hybrid-electric vehicles versus conventional vehicles in National Research Council, National Academy of Engineering, *The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs*, The National Academies Press, 2004. This means that a conventional gasoline-powered vehicle uses 1.45 times as much energy as a hybrid-electric vehicle.

33. 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.

34. California Environmental Protection Agency, Air Resources Board, *ARB Approves Greenhouse Gas Rule* (press release), 24 September 2004.

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

36. 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 most recent 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

37. California Environmental Protection Agency, Air Resources Board, *ARB Approves Greenhouse Gas Rule* (press release), 24 September 2004.

38. 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.

39. Catherine Witherspoon, California Environmental Protection Agency, Air Resources Board, Regulations to Control Greenhouse Gas Emissions from Motor Vehicles, presentation at STAPPA/ALAPCO Fall Membership Meeting, 23-27 October 2004.

40. 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.

41. For a fuller list of transportation policy options, see 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.

42. 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.

43. See note 36.