Global Warming Solutions: A Progress Report

Policy Options to Reduce Oregon's Contribution to Global Warming

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Environment Oregon
Research & Policy Center

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Table of Contents

Executive Summary

Global warming poses a serious threat to Oregon's future well-being and prosperity. To avoid the worst impacts of global warming, Oregon should reduce its global warming pollution at least 25 percent by 2020 and 80 percent by 2050, setting an example for the rest of the nation to follow.

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

This report summarizes the state of the science and the necessary scope of pollution reductions. It then provides a progress report on Oregon's work to reduce global warming pollution by detailing the expected pollution reductions from policies that Oregon has already adopted, and, finally, identifies six additional policies that would enable Oregon to meet its pollution reduction goals for 2020.

Global warming is happening now and poses a serious threat to Oregon's future. Global average temperatures increased by more than 1.4° F in the past century. Sea level is rising, ice and snow cover are decreasing, and storm intensity has increased. Scientists have tied this warming to human activity, particularly the burning of fossil fuels, which releases carbon dioxide, a pollutant that traps radiation from the sun near the earth's surface. Since 1750, the concentration of carbon dioxide in the atmosphere has increased by 35 percent, reaching the highest level of the last 650,000 years.

The current warming has already affected the Earth's climate. In Oregon, scientists have linked global warming to shrinking glaciers and declining spring snowpack, a primary source of river water that supplies communities with drinking water and farmers with irrigation. Oregon has also experienced more frequent and severe forest fires.

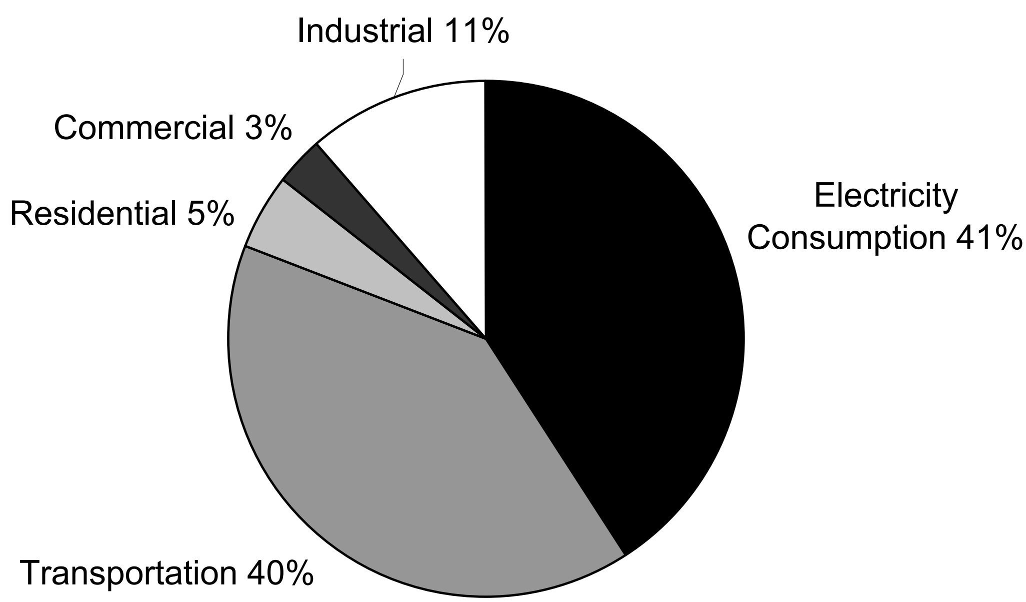
Scientists estimate that world average temperatures could increase by another 3 to 7° F above late 20th century levels by the end of this century, depending on future emissions of global warming pollutants. Sea level could rise by between 11 and 17 inches, and possibly more, threatening low-lying coastal areas. Rising temperatures and shifting patterns of precipitation could disrupt the ecological balance upon which life depends. In Oregon, higher temperatures would increase wintertime flooding and erosion, further reduce snowpack, increase forest fires, and threaten salmon survival.

Emissions of global warming pollution rose in Oregon until at least 2005. Between 1990 and 2005, Oregon's emissions of carbon dioxide from energy use increased by 23 percent. Electricity consumption and transportation are the biggest sources of carbon dioxide pollution in the state (with a 41 percent and 40 percent share, respectively), followed by the direct use of fossil fuels in industry (11 percent), homes (5 percent) and businesses (3 percent). (See Figure ES-1.)

Immediate action is needed to prevent the worst impacts of global warming. Scientists have projected that if we act quickly and aggressively to reduce global warming pollution there is a much greater chance of staving off the worst impacts of global warming. A survey of numerous studies shows that to keep global temperatures from rising by more than 2.0° C (3.6° F), the world will need to halt the growth of global warming pollution by 2015 at the latest, begin reducing emissions immediately thereafter, and slash emissions by 50 percent to 85 percent by 2050. Because the United States is the world's largest global warming polluter, the degree of emission reductions required here will be greater than in less-developed countries and must be at the high end of this range.

Oregon has set appropriate science-based goals for reducing global warming pollution. In 2007, the Oregon Legislature adopted Governor Ted Kulongoski's goals of arresting growth in global warming pollution by 2010, reducing pollution to 10 percent below 1990 levels by

Figure ES-1. Oregon's Carbon Dioxide Pollution by Sector, 2005



2020, and cutting pollution 75 percent below 1990 levels by 2050. Oregon's goals translate to a 27 percent reduction in 2020 from 2005 emission levels and an 80 percent reduction in 2050 from 2005 emission levels. Assuming that Oregon makes steady progress in reducing emissions from 2020 to 2050, the state would need to cut emissions by 44 percent from 2005 levels by 2030. This puts Oregon among the few states that have set goals consistent with the scale of action scientists have determined will be necessary to avoid the most catastrophic effects of global warming.

If Oregon had not already begun to take steps to reduce pollution, the state would be on a path toward significant increases in global warming pollution. Absent decisive policy action, Oregon's emissions of carbon dioxide from fossil fuel use would increase 17 percent over 2005 levels by 2020 and 41 percent by 2030, with increases in emissions from electricity consumption responsible for the bulk of emissions growth.

By adopting several significant policies, Oregon already has changed its emissions path. The following recently enacted policies mean the state is on pace to meet its 2010 goal of arresting growth in pollution, and is more than halfway toward its 2020 goal of reducing pollution by 27 percent from 2005 levels.

1. **Clean Cars Program.** The Clean Cars Program will impose limits on global warming emissions from new cars and trucks and offer Oregon residents a greater selection of low-emission vehicles, including hybrid-electric vehicles. The standards will likely continue to be strengthened in the coming years, delivering additional emission reductions.

2. **Energy-saving residential building energy codes.** Oregon has adopted the strongest energy codes in the nation for residential buildings, which will reduce energy use and thus global warming pollution.

3. **Energy efficiency programs.** Energy efficiency programs funded by ratepayers are increasing investment in cost-effective energy efficiency measures that help to reduce electricity and natural gas use. The state's large electric and natural gas utilities operate efficiency programs of their own, as do some smaller, public utilities.

4. **Renewable electricity standard.** Oregon has adopted a law requiring large utilities to acquire 25 percent of the electricity they sell from renewable sources, with lower requirements for smaller utilities. By 2025, an average of 20.5 percent of the electricity sold in Oregon will come from new renewable sources.

5. **Reduced government energy use.** Oregon state government has adopted a number of policies to reduce energy use in buildings through conservation and efficiency.

Oregon has adopted several other policies that reduce vehicle travel, including its landmark land use planning program that limits sprawling, auto-dependent development and a program that requires major employers to reduce single-occupant driving to work by promoting carpools, transit, telecommuting and other options. The Portland metropolitan area has gone further, effectively implementing land use planning programs, investing in transit and making the city friendlier to cyclists. These policies provide additional emission reductions not quantified in this report.

The first step Oregon should take in order to meet its goals is to adopt a mandatory cap on global warming pollution

that will commit the state to reducing pollution by 27 percent below 2005 levels by 2020 and 80 percent below 2005 levels in 2050. Furthermore, Oregon should adopt a program to meet the cap, such as the cap-and-trade system being developed within the Western Climate Initiative. A strong cap will help to drive pollution reductions from all categories of energy use and will ensure that reductions in one sector are not offset by increased emissions elsewhere.

The six policy strategies identified below can allow the state to exceed its goal of reducing pollution 27 percent below 2005 levels by 2020. By 2030, the policies should enable it to achieve 88 percent of its targeted pollution reduction, leaving emissions 18 percent above the target for that year. (See Table ES-1.) These savings are possible if adopted in conjunction with a mandatory cap and the policies Oregon already has in place.

1. **Establish a target of reducing vehicle miles traveled 10 percent from 2008 levels, and implement programs to meet the target.**

    - Adopt measures to reduce dependence on single-passenger car trips, including reducing sprawling development and expanding the use of transit and other transportation choices. Major metropolitan areas should be making regional transportation plans and developing transportation projects that increase transportation choices and help Oregonians reduce their dependence on driving.

    - Expand mileage-based automobile insurance. Require automobile insurers to offer insurance with rates based on the amount traveled. This will reward those who drive less and potentially reduce accidents.

    - Strengthen the existing commute-trip reduction law. Large employers should be required to do more to discourage single-passenger commuting and provide employees with more transportation choices to cut single-occupant vehicle commutes by 40 percent by 2020.

2. **Adopt a low-carbon fuel standard.** A portion of motor fuel sold in Oregon should come from sources with lower life-cycle emissions than gasoline or diesel to reduce the carbon intensity of the fuel mix by 10 percent by 2020 and 20 percent by 2030.

3. **Reduce fuel use in heavy-duty diesel vehicles.** Oregon should adopt measures to improve the aerodynamics of heavy diesel trucks by at least 8 percent and urge the federal government to improve the fuel efficiency of medium- and heavy-duty vehicles that use diesel fuel by 50 percent.

4. **Expand energy efficiency programs.** Higher targets for energy savings in homes and businesses, the inclusion of the industrial sector in statewide efficiency goals, and greater funding to help homeowners and businesses retrofit existing buildings would further cut energy use and global warming pollution.

5. **Improve building energy codes for new homes and businesses.** Oregon should adopt energy codes for new residential and commercial buildings that will result in buildings that use net zero energy by 2030.

6. **Adopt an emissions performance standard for electricity generation**.

Table ES-1. Emission Reductions from the Policies (million metric tons of carbon dioxide)

Policy	2010	2020	2030
Existing Policies			
Clean Cars Program	0.0	1.0	1.3
Residential and Commercial Building Codes	0.0	0.1	0.3
Energy Efficiency Programs + Appliance Standards	2.9	4.1	2.9
Renewable Electricity Standard	0.0	9.0	12.3
Public Sector Efficiency Requirements	0.8	3.1	4.2
Total Savings of Existing Policies	3.5	16.0	19.3
New Policies			
Reduced Vehicle Travel	0.5	2.3	3.8
Low-Carbon Fuel Standard	0.0	2.1	4.5
Heavy-Duty Diesel Truck Improvements	0.0	0.7	2.9
Expanded Energy Efficiency Programs	0.7	3.9	4.7
Stronger Building Codes	0.3	5.2	16.7
Emissions Performance Standard for Electricity	0.9	4.7	13.4
Total Savings of All Policies	**7.9**	**33.1**	**43.2**

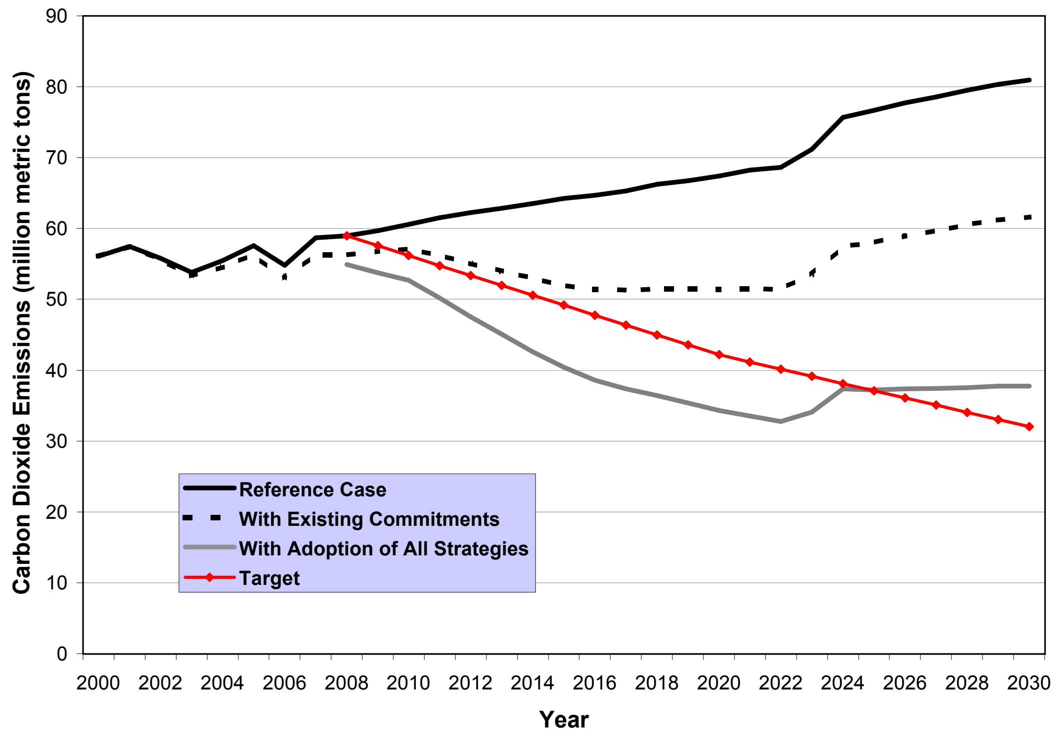
Savings from individual polices do not equal cumulative savings due to overlap and interaction between the policies.

An emissions performance standard would establish a maximum amount of global warming pollution that can be released by power plants generating electricity, whether located in Oregon or located elsewhere but generating power for consumption in Oregon.

Oregon should adopt policies that will ensure the state reduces global warming pollution to the extent scientists estimate is necessary to avoid catastrophic climate change. Already, the state has established a goal of reducing emissions by 27 percent below 2005 levels by 2020 and 80 percent below 2005 levels by 2050. However, the legislation that confirmed those goals did not establish clear mechanisms that would accomplish these targets. To ensure that Oregon achieves these targeted reductions, the state should:

- Adopt a binding cap on global warming emissions with a program, such as a cap-and-trade program, to meet the cap.
- Grant state agencies the authority to implement measures that will help meet the cap.
- Ensure the full implementation of emission-reduction policies already adopted.
- Adopt the six additional strategies recommended in this report.
- Take additional actions to reduce global warming pollution, especially in areas not directly addressed in this report, such as emissions from air travel and industrial energy use and emissions of global warming pollutants other than carbon dioxide.

Figure ES-2. Oregon's Carbon Dioxide Emissions from Energy Use after Adoption of Recommended Strategies



Introduction

Oregon is vulnerable to the threat posed by global warming. For example, as temperatures have increased, glaciers have begun to shrink and spring snowpack has begun declining, threatening reduced summer water supplies. Sea level has already started to rise.

Global warming will bring with it many other ecological and economic threats. A recent study by Sir Nicholas Stern, head of the British Government Economics Service and former World Bank chief economist, estimates that inaction on global warming will cost the equivalent of 5 to 20 percent of worldwide economic output.[1] Oregon's share of this economic damage is unknown but with an economy that includes strong contributions from agriculture, tourism and hydropower, the impacts will be significant.

Fortunately, Oregon still has time to act. Cutting emissions of pollutants that trap heat in the earth's atmosphere will set Oregon on a path to avoid the worst impacts of global warming.

Taking action will also create economic and social benefits for Oregonians. Oregon consumers and businesses will save money on energy bills and gas as the state takes measures to reduce energy consumption and driving. The economy will grow as the state invests in renewable energy research, develops its renewable energy manufacturing capacity, and implements energy efficiency measures. Reducing the amount of fossil fuel (especially petroleum) consumed in Oregon will keep more dollars local and support the state's economy.

As Oregon develops and deploys new and improved technologies—from advanced vehicles to highly efficient appliances—the state will be in a better position to achieve greater reductions in emissions in the decades to come.

Making these changes will require an unprecedented amount of research, discussion, cooperation and political will. By using existing technologies and reasonable public policy tools, Oregon can reduce the state's contribution to global warming, while in many cases improving public health, economic well-being and energy security, and providing a model of leadership for others to follow.

The strategies laid out in this report show the way forward.

Global Warming and Oregon

Human Activities Are Causing the Climate to Warm

Human activities, particularly over the last century, have altered the composition of the atmosphere, causing it to retain more of the sun's heat.

Since 1750, the concentration of carbon dioxide, the leading global warming pollutant, in the atmosphere has increased by 35 percent as a result of human activity.[2] The rate at which the concentration of carbon dioxide has increased has accelerated over the past century as we have burned more fossil fuels. The current concentration of carbon dioxide in the atmosphere is higher than it has been in the last 650,000 years.[3] (See Figure 1.) Concentrations of other global warming pollutants have increased as well.

Current Indications of Global Warming

Signs of global warming are beginning to appear in Oregon and throughout the world. Global average temperatures increased during the 20th century by about 1.3° F (0.74° C).[10] (See Figure 3, page 12.) While this increase may not seem extreme, it is unprecedented in the context of the last 1,300 years of world history.[11]

Global warming has intensified in recent years. In 2006, scientists at the National Aeronautics and Space Administration (NASA) reported that, since 1975, temperatures have been increasing at a rate of about 0.36° F per decade.[13] Nationally, six of the last 10 years (1998 to 2007) rank among the 10 warmest years on record.[14]

This warming trend cannot be explained by natural variables—such as solar cycles or volcanic eruptions—but is successfully predicted by models of climate change that include human influence.[15]

Other indications of global warming include:

- **Melting ice** – The rise in global temperatures has resulted in thinning ice and decreasing snow cover. Glaciers are retreating around the globe and the annual extent of Arctic sea ice has declined by 2.7 percent per decade since 1978.[16] NASA scientists found a 23 percent decrease in the extent of Arctic sea ice from winter 2005 to winter 2007.[17] Glaciers through the Cascades are shrinking and spring snowpack has declined as much as 35 percent since mid-century.[18]

- **Rising sea levels** – Oceans have risen with the melting of glacial ice and the expansion of the ocean as it warms. Average sea level has risen 6.7 inches in the past century.[19] In Oregon, sea level at South Beach is rising at a rate of 1.15 feet per century.[20]

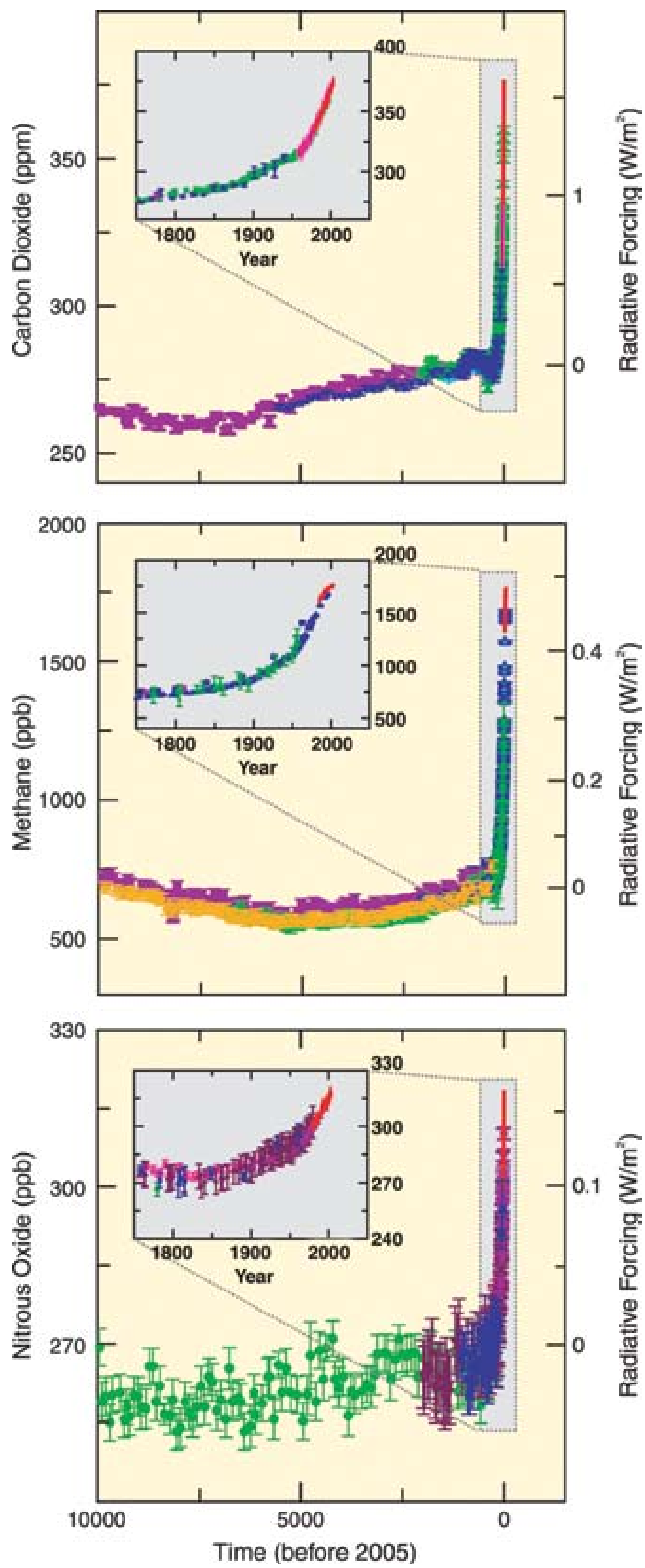
- **Shifting seasons** – Spring events—such as leaf unfolding, egg laying and bird migration—are occurring earlier in the year. Numerous species of plants and animals appear to be moving toward the poles in response to rising temperatures.[21]

- **More severe storms** – Storms may be getting more intense. For example, an increase in the fraction of rainfall occurring as heavy precipitation events has been observed, a potential result of warmer air that is able to hold more moisture.[22] Hurricanes appear to have become more powerful and more destructive over the last three decades, a phenomenon that some researchers link to increasing global temperatures.[23]

- **Longer and more severe forest fire seasons** – Since the mid-1980s, large wildfires have been more common and have lasted longer and the overall length of the wildfire season has been longer.[24]

In the Pacific Northwest, recent signs of global warming include an increase in average temperature of 1.5° F (0.8° C) during the 20th century.[25] Over the same period precipitation has also increased, especially in the springtime.[26]

Figure 1. Atmospheric Concentrations of Global Warming Pollutants[4]



Global Warming Pollutants

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

- **Carbon Dioxide** – Carbon dioxide is released mainly through the combustion of fossil fuels. Carbon dioxide is the leading global warming pollutant. In 2000, carbon dioxide emissions represented approximately 84 percent of Oregon's annual contribution to global warming.[5]

- **Methane** – Methane gas escapes from garbage landfills, is released during the extraction of fossil fuels, and is emitted by livestock and some agricultural practices. Methane represents about 7 percent of Oregon's global warming emissions.[6]

- **Nitrous Oxide** – Nitrous oxide is released in automobile exhaust, through the use of nitrogen fertilizers in agriculture, and from human and animal waste. It is responsible for about 6 percent of Oregon's contribution to global warming.[7]

- **Fluorocarbons** – Used in refrigeration, air conditioning and other products, many fluorocarbons are also global warming pollutants. Emissions of some fluorocarbons have increased significantly in recent years as they have been used to replace ozone-depleting substances. However, because they are generally emitted in small quantities, fluorocarbons are responsible for only about 2 percent of the U.S. contribution to global warming.

- **Sulfur Hexafluoride** – Sulfur hexafluoride (SF_6) is mainly used as an insulator for electrical transmission and distribution equipment. It is an extremely powerful global warming gas, with more than 20,000 times the heat-trapping potential of carbon dioxide. It is released only in very small quantities and is responsible for only a very small portion of the nation's global warming emissions, but there are cost-effective alternatives for controlling existing emissions.

- **Black Carbon** – Black carbon is a product of the burning of fossil fuels—particularly coal and diesel fuel—and biofuels. Black carbon, also known as soot, absorbs sunlight and radiates heat back into the atmosphere. Soot that is deposited onto ice accelerates melting; as a result, black carbon hastens the warming of the Arctic. Researchers estimate that emissions of black carbon in the U.S. are second in importance only to carbon dioxide in terms of warming.[8] Soot's warming effects are short-lived compared to other pollutants and thus controlling emissions of black carbon can have an immediate effect on warming.

Global Warming Will Have Severe Impacts—Unless We Act Now

Climate scientists warn that the world faces dire environmental consequences unless we find a way to quickly and rapidly reduce our emissions of global warming pollutants. Global warming will have serious impacts on Oregon's natural environment and thus its economy and way of life.[27]

Future Global Impacts

Many scientists and policy-makers recognize a 3.6° F (2° C) increase in global average temperatures over pre-industrial levels as a rough limit beyond which large-scale, dangerous impacts of global warming would become unavoidable.[28] Even below 3.6° F, significant impacts from global warming are likely, such as damage to many ecosystems, decreases in crop yields, sea level rise, and the widespread loss of coral reefs.[29]

Beyond 3.6° F, however, the impacts of global warming become much more severe, including some or all of the following possible impacts:

- A 0.7 to 1.9 foot sea level rise, even without rapid change in ice flow patterns;[30]
- Eventual loss of the Greenland ice sheet, triggering a sea-level rise of 7 meters over the next millennium (and possibly much faster);
- Widespread extinctions of plant and animal species;
- Displacement of tens of millions of people due to sea level rise;
- Expansion of insect-borne disease;
- Increased coastal flooding and the loss of 30 percent of coastal wetlands;
- A further increase in the intensity of hurricanes;

Figure 2. Oregon's Global Warming Emissions by Pollutant (carbon dioxide equivalent)[9]

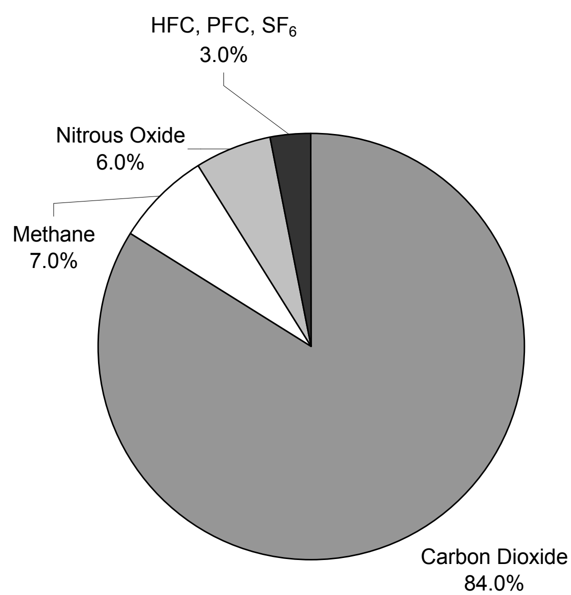
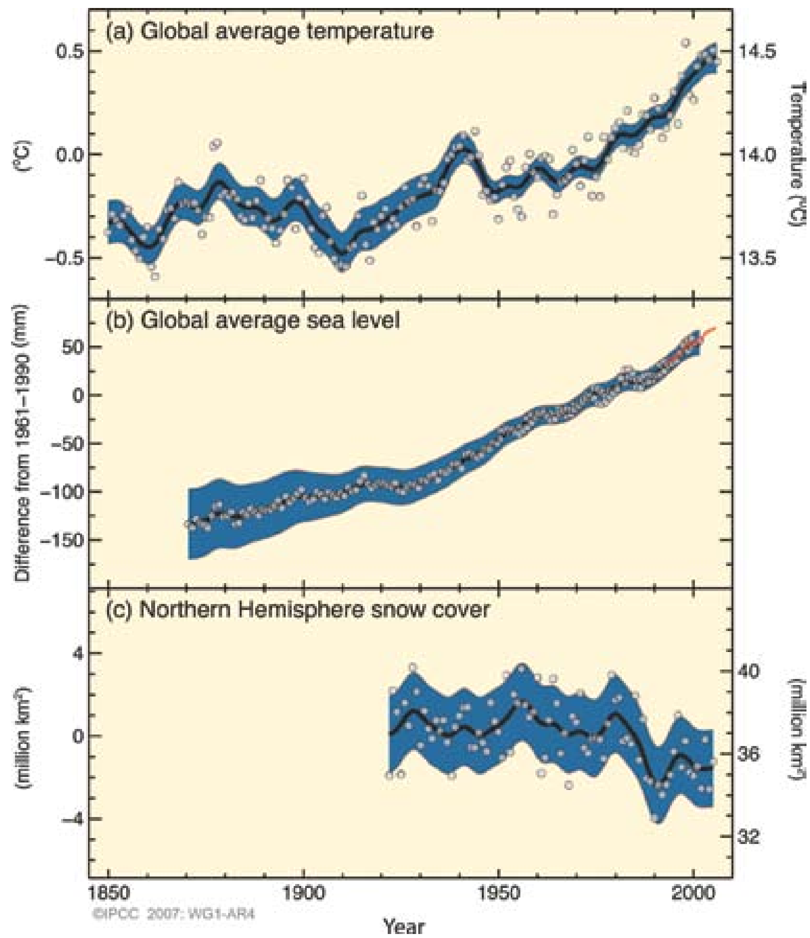


Figure 3. Changes in Global Average Temperature and Sea Level and Northern Hemisphere Snowpack, Difference from 1961-1990 Average[12]



- Greater risk of positive feedback effects—such as the release of methane stored in permafrost—that could lead to even greater warming in the future.[31]

Should the world continue on its current course, with fossil fuel consumption continuing to rise, temperature increases of well above 2° C are likely to occur. The Intergovernmental Panel on Climate Change, in its 2007 *Fourth Assessment Report*, laid out a scenario in which population, economic output and fossil fuel consumption continue to grow dramatically. Under that scenario, global average temperatures by the end of the century would be approximately 7.2° F (4.0° C) higher than in 1990, and temperatures would continue to rise for generations to come.[32]

Future Oregon Impacts

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

The Pacific Northwest's climate is expected to grow warmer, with temperatures increasing by 0.5° F every decade through the 2050s above late 20th century levels.[33] Total temperature increase by the 2080s could be as high as 9.7° F. As a result of this and other changes, the region will experience a variety of impacts.

Water supplies may be limited. Warmer temperatures will cause more precipitation to fall as rain, rather than snow, affecting water availability. In the Northwest, more water is stored as snow than in reservoirs. Snow effectively holds precipitation, releasing it in the spring and summer as temperatures warm. As more precipitation falls as rain, however, winter and early spring streamflows will increase and summertime streamflows will decrease.[34] Less water may be available for irrigation of farmland, for salmon, and for other water users.

Oregon's oceans may change, also. Marine animals depend on the upwelling of nutrient-rich water to deliver food. Changes in the timing and size of the upwelling may affect animals' ability to reproduce, and may even cause some to starve. Already, changes in wind and currents have triggered near-shore upwelling every summer since 2002 that has caused a dead zone where fish and other animals cannot survive.[35]

Erosion may become more severe. The Pacific Northwest is expected to receive heavier winter rainfall. Experience with El Niño and La Niña events has shown that heavy rain saturates soils, causing landslides, and causes coastal flooding from overflowing rivers. Higher sea levels will further increase coastal erosion.[36]

Key Oregon natural resources will be damaged. Salmon will struggle with winter flooding, higher water temperatures, and declining summer water availability. Trees may grow faster due to increased precipitation, but forest fires are also expected to become more frequent.[37]

An Urgent Need for Strong Action

The climate science leaves room for hope, however, that if we act quickly and aggressively to reduce global warming emissions, there is a much greater chance of staving off the worst impacts of global warming. To have a reasonable chance of keeping global temperatures from rising by more than 2° C, the atmospheric concentration of global warming pollutants (in carbon dioxide equivalent) must rise no higher than 445 to 490 parts per million (ppm).[38] Given that the concentration of global warming pollutants is already 375 ppm and rising every year, the need for action is immediate.[39] Recently, some climatologists, including NASA's James Hansen, have even called for a swift return to 350 ppm, which is below the current concentration of global warming pollutants in the atmosphere and would require steep, immediate reductions in emissions worldwide.[40]

To stabilize carbon dioxide levels between 445 and 490 ppm (carbon dioxide equivalent), the IPCC concludes that global emissions must peak no later than 2015 and decline by 50 to 85 percent below 2000 levels by 2050.[41] Because the U.S. is the world's largest global warming polluter, the degree of emission reductions required here will be greater than in less-developed countries.

Oregon has already adopted some of the strong policies required to reduce its global warming pollution. But curbing the state's pollution will require additional action, including adoption of aggressive state and regional targets for reducing Oregon's substantial contribution to global warming.

Global Warming Pollution in Oregon

Oregon is a significant contributor to global warming, mainly through the release of carbon dioxide resulting from consumption of fossil fuels. In 2005, the last year for which complete data are available, the use of fossil fuels and electricity in Oregon was responsible for the release of approximately 57.6 million metric tons of carbon dioxide, the leading global warming pollutant.[42] Were Oregon its own country, it would have ranked 54th in the world for carbon dioxide emissions during 2005, ahead of nations such as Denmark and Ireland.[43]

Oregon's emissions of carbon dioxide have been increasing and would increase further in the absence of concerted action to reduce global warming pollution. Various sectors of Oregon's economy are responsible for varying amounts of global warming pollution and require different strategies to reduce emissions.

Rising Emissions

Between 1990 and 2005, carbon dioxide emissions from energy use in Oregon

A Note on Units

In this report, we focus on emissions of carbon dioxide and do not include other global warming pollutants, such as methane or nitrous oxide. Thus, we report emissions in terms of carbon dioxide. One million metric tons of carbon dioxide is expressed as $MMTCO_2$. One metric ton of carbon dioxide is equal to the amount released by the average model year 2007 passenger vehicle after being driven 2,300 miles.[44] One million metric tons is the amount of carbon dioxide released by 192,000 average passenger vehicles in a year.[45]

increased by 10.7 $MMTCO_2$—or about 23 percent—a rate of increase higher than that of the U.S. as a whole, which has seen carbon dioxide emissions increase by 19 percent during that same period.[46]

Oregon's emissions of carbon dioxide are expected to rise over the next two decades. In the absence of measures to reduce global warming pollution, the state's carbon dioxide emissions would be expected to increase by 17 percent over 2005 levels by 2020 and by 41 percent by 2030. Over the next 25 years, Oregon's emissions from all sectors would be expected to increase, with the greatest increase taking place in the electric sector.

Sources of Carbon Dioxide Emissions in Oregon

A coherent strategy to address global warming pollution in Oregon must begin from an understanding of the sources of the pollution. (See Figure 4.) The transportation and electric sectors are the leading sources of global warming emissions in Oregon and will continue to be so in the coming years. However, pollution from all sectors of the economy is projected to increase by varying degrees over the next 25 years. (See Figure 5, next page.)

Electric Sector

Electricity generated for consumption in Oregon is the largest source of carbon dioxide emissions in Oregon, responsible for about 40.8 percent of the state's emissions. Oregon exports zero-emission electricity from hydropower but imports electricity from coal and natural gas. This imported power has much higher emissions than power generated in the state. Emissions from electricity consumed in Oregon increased by 30 percent between 1990 and 2005.

The federal projections on which our data are based show that electric sector emissions are expected to grow substantially in coming years, thanks to the construction of additional coal-fired generating capacity in the region. Even if those new facilities are not located in

Figure 4. Oregon's Carbon Dioxide Pollution by Sector, 2005

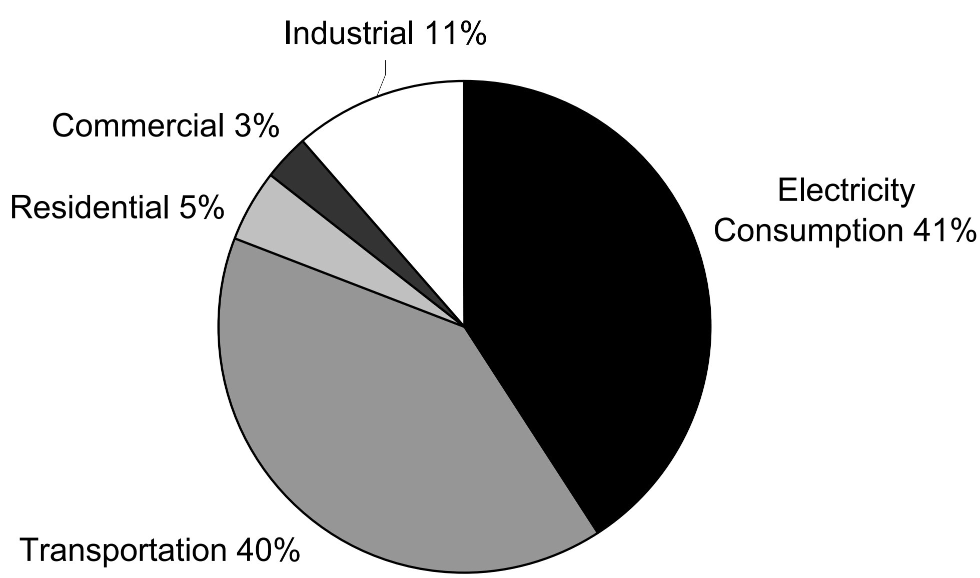
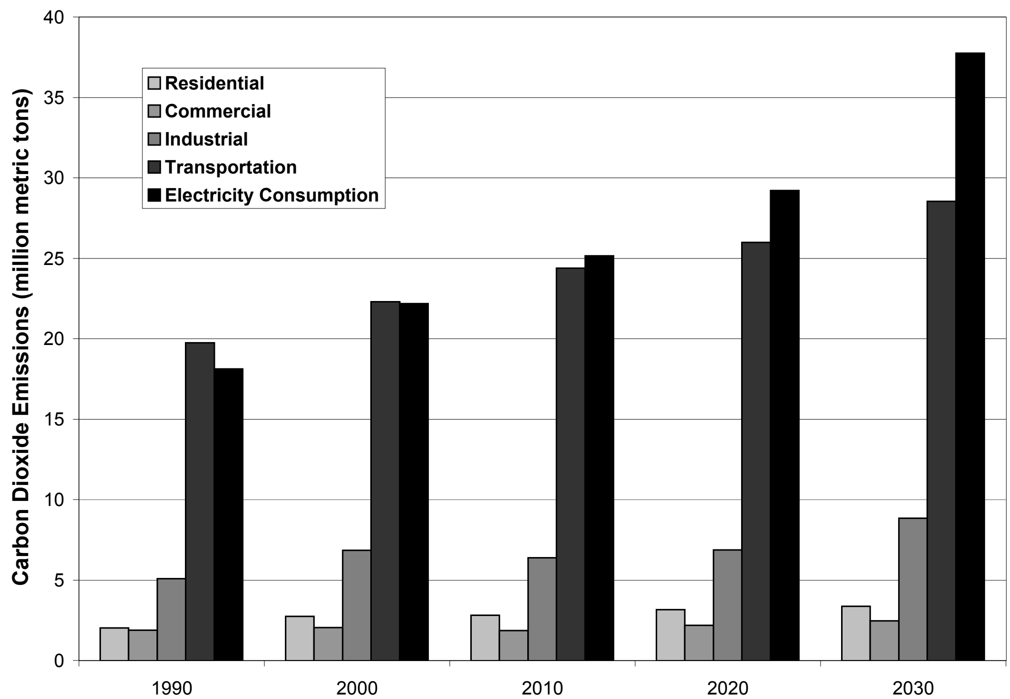


Figure 5. Carbon Dioxide Emissions by Sector, 1990-2030



Oregon, the power that they generate may be sold to consumers in the state, effectively increasing the state's contribution to global warming pollution. Assuming a large increase in coal-fired generation, as the federal Energy Information Administration does, emissions from electricity could rise by 62 percent by 2030.

Transportation

In 2005, Oregon's transportation sector essentially tied the electricity sector as the largest source of carbon dioxide emissions, at 40.1 percent of the state's energy-related carbon dioxide emissions. Between 1990 and 2005, global warming pollution from transportation increased by 16.9 percent.

Personal vehicles such as cars, pick-up trucks and SUVs are the source of more than half of transportation-related global warming pollution in Oregon.[47] Diesel fuel, used most commonly in heavy trucks for hauling freight, accounts for 27 percent of transportation emissions. Jet fuel is responsible for 9 percent of transportation emissions, while fuel used primarily in ships accounts for 4 percent. (See Figure 6.)

Emissions from travel in personal vehicles and freight-hauling in trucks rose significantly from 1990 to 2005. The number of miles traveled on Oregon's roads increased by 49 percent from 1990 to 2005, to more than 35 billion miles per year.[48] Emissions from aviation increased by 63 percent.

Over the next two and half decades, global warming pollution from gasoline consumption in Oregon (most of it used in cars and light trucks) is expected to remain constant, thanks to new federal fuel economy standards and modest projected increases in driving. Consumption of diesel fuel (used primarily in heavy-duty trucks) is poised to increase by 61 percent.

Emissions from aviation are expected to rise 62 percent. Reducing global warming emissions from Oregon's transportation sector, therefore, will require action on a number of fronts.

Industrial Energy Use

Industrial energy consumption, which includes agricultural energy consumption for growing and processing food, accounted for 11.3 percent of Oregon's carbon dioxide emissions in 2005 (excluding emissions from electricity consumed in the industrial sector). Carbon dioxide emissions from industrial energy use increased by 28 percent between 1990 and 2005. Carbon dioxide emissions from industry are expected to increase by 36 percent by 2030.

Residential and Commercial Energy Use

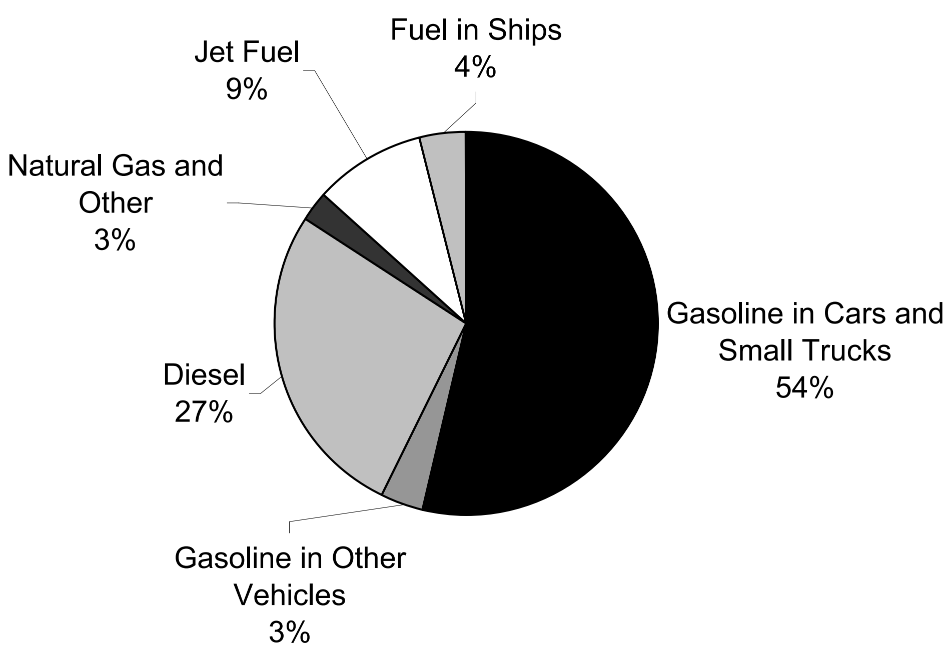
Direct consumption of fossil fuels—such as natural gas, home heating oil, and propane (but not electricity)—in Oregon homes accounted for 4.6 percent of the state's carbon dioxide emissions in 2005. Emissions from the residential sector increased by 32 percent from 1990 to 2005.

Direct fossil fuel consumption in commercial buildings accounts for the remaining 3.2 percent of Oregon's carbon dioxide emissions. Carbon dioxide pollution from commercial buildings declined by 2 percent between 1990 and 2005. Electricity consumption increased, rising by 27 percent in commercial buildings over that time period, helping to fuel the increase in global warming emissions from electricity generators since 1990.

Addressing Global Warming Pollution in Oregon

Oregon must address global warming emissions from all sectors of the state's economy. The state has already adopted non-enforceable pollution-reduction goals of cutting emissions by 27 percent below 2005 levels by 2020 and by 80 percent

Figure 6. Source of Transportation-Sector Global Warming Emissions



below 2005 levels by 2050. Oregon's goals put it among the few states that have set goals consistent with the scale of action scientists have determined will be necessary to avoid the most catastrophic effects of global warming.

Oregon should turn these goals into enforceable targets that encompass pollution from all sources.

In addition to an economy-wide cap, Oregon can adopt specific policies to cut emissions from different sectors of energy use. Below, we assess the pollution-reduction benefits of major policies currently in place, and identify some of the many policy options that have the potential to meet Oregon's goals for curbing global warming emissions in the state, while boosting Oregon's energy security and the long-term health of its economy.

Oregon's Initial Global Warming Pollution Reduction Policies

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

An Evaluation of Existing Policies

Clean Cars Program

Projected Savings:
1.0 $MMTCO_2$ by 2020
1.3 $MMTCO_2$ by 2030

In 2005, Oregon adopted the Clean Cars Program, which will lead to lower emissions of toxic and smog-forming pollutants, require the development of low-polluting, high-technology vehicles, and cut global warming pollution from cars and light trucks.[49]

The federal Clean Air Act allows states to choose between two sets of emission standards: those in place at the federal level and the traditionally tougher standards adopted by the state of California, known as the Clean Cars Program. A total of 14 states have adopted the Clean Cars Program.[50] Several others are considering adopting the program.

The global warming pollution standards within the Clean Cars Program reflect "the maximum feasible and cost effective reductions of greenhouse gas emissions from motor vehicles," as required by California law.[51] The California Air Resources Board (CARB) has established emission limits through model year 2016. These limits will produce significantly greater reductions in global warming pollution than will the new gas mileage standards established by the federal government in late 2007, and early indications suggest the Clean Cars Program will be even stronger in years to come. CARB estimates that annual global warming pollution savings in Oregon in 2020 will be 43 percent greater with the

Clean Cars Program than with the upgraded federal gas mileage standards.[52]

In estimating the benefits of the global warming and vehicle standards, we assume that Oregon vehicles will achieve the same percentage emission reductions as estimated by CARB—34 percent for new cars and 25 percent for new light trucks by 2016 compared to vehicles manufactured in 2002.[53] Adoption of the standards would lead to net consumer benefits of an estimated $20 per month for new car purchasers and $27 per month for light-truck buyers, with the higher cost of vehicles being more than offset by reductions in operating costs, primarily the cost of fuel (assuming that gas costs $3 per gallon).[54]

We further assume that California will strengthen its emission standards after model year 2016. Though regulations for the years after 2016 have not yet been finalized, preliminary discussion by CARB suggests that by 2020, pollution from driving a mile in a new car or a small light truck will be reduced by 44 percent from 2002 levels and pollution from driving a mile in a new large light truck will be cut by 40 percent.[55] Because so many older cars will still be on the road, the vehicle fleet will remain relatively polluting and additional steps will be needed to reduce global warming pollution from transportation.

Residential Building Energy Codes

Projected Savings:
0.1 MMTCO$_2$ by 2020
0.3 MMTCO$_2$ by 2030

Building codes are used to set minimum energy efficiency standards and reduce the amount of energy wasted in heating, cooling, lighting, and the use of electrical equipment. Because residential and commercial buildings can last for decades, adopting and enforcing strong building

Seeking Federal Approval of the Clean Cars Program

The Clean Air Act allows states to choose California's emissions standards, which are more protective than the federal standards. However, before California and those states that are opting in can implement a new policy, the U.S. Environmental Protection Agency must issue California a waiver.

Historically, EPA has approved more than 40 waivers giving California permission to pursue stronger environmental protections.[56] In December 2007, however, EPA denied a waiver for the global warming pollution standards of the Clean Cars Program. The EPA administrator issued his denial despite a recommendation from EPA staff that the agency should grant California permission and would be likely to lose a lawsuit if California sued.[57]

The Obama administration is in the process of reconsidering the EPA's earlier decision to deny the waiver. Implementing the Clean Cars Program is the best way to reduce global warming pollution from cars and light trucks and is central to many states' efforts to reduce their global warming pollution. In the 14 states that have adopted the standards, the Clean Cars Program will reduce emissions by a total of 135 million metric tons of carbon dioxide by 2020, compared to federal fuel economy standards.[58]

Should the Obama administration issue the waiver, or states prevail in their legal challenge, Oregon would be able to implement the program as soon as 2010.

codes is crucial for avoiding excessive energy consumption over the long term.

Oregon has a mandatory, statewide building code. Effective July 1, 2008, new residential building codes reduce energy consumption from new homes by 15 percent below 2007 levels, giving the state the strongest residential energy code in the nation.[59] Commercial buildings are also subject to a state-developed code, though it is not as strong as the residential code. Both residential and commercial codes are updated at least every three years.[60]

The savings will result in a 0.1 $MMTCO_2$ reduction in global warming emissions by 2020 and 0.3 $MMTCO_2$ by 2030.

Energy Efficiency Requirements and Appliance Efficiency Standards

Projected Savings:
4.1 $MMTCO_2$ by 2020
2.9 $MMTCO_2$ by 2030

Energy efficiency improvements are among the most promising and least costly ways to reduce global warming emissions. Residential and commercial efficiency savings can be achieved with more efficient lighting, better insulation and weathersealing of buildings, and more efficient furnaces, air conditioners, and other appliances. In the industrial sector, potential efficiency improvements include more efficient motors, furnaces, ovens, cooling and drying, and compressed air systems.

The Energy Trust of Oregon administers programs and incentives to help residential, commercial and industrial consumers maximize their energy efficiency. Funded by a public purpose charge enacted by the Oregon Legislature and paid by customers of investor-owned electric utilities and by non-industrial customers of investor-owned natural gas utilities, the Energy Trust opened its doors in 2002. The PUC has established rigorous goals for the Energy Trust for 2012, including:

- Saving a cumulative 300 average MW of electricity, and
- Saving a cumulative 21 million therms of natural gas.[61]

The Energy Trust has made important progress toward these goals. By the end of 2007, its broad range of programs had helped Oregon:

- Save 158 average MW (59 percent of the 2012 goal), and
- Save 6.7 million therms of natural gas (32 percent of the 2012 goal).[62]

Electricity savings produced in 2007 cost just 1.4 cents per kilowatt-hour, less than one quarter the cost of buying a kilowatt-hour of electricity.

Legislation passed in 2007 extended the Energy Trust's mandate to 2025 and increased potential funding for electricity efficiency work.[63] The Energy Trust currently is working to establish specific new savings goals.

In addition to assessing the public purpose charge to support the work of the Energy Trust, electric utilities can request permission from the PUC to collect funds to pay for additional energy efficiency programs in their service territory. The state's two largest investor-owned utilities have received permission from the Public Utility Commission to collect additional funds from customers for energy efficiency. Using ratepayer funds, PacifiCorp will spend $55 million from 2008 to 2012 to boost energy efficiency by 36 average MW, while PGE will spend $70 million to acquire 42 average MW of energy efficiency.[64] The utilities will provide funding to the Energy Trust, allowing it to expand and improve existing programs.

Oregon also implemented energy efficiency standards for specific lighting, power supply and cooling appliances, equipment not covered by federal standards.[65] With the combined effect of these programs, Oregon is among the nation's leaders for energy efficiency—but still could obtain greater global warming emission reductions through even more efficiency improvements, as discussed later in the section titled "Expand Energy Efficiency Programs."[66]

Renewable Electricity Standard

Projected Savings:
9.0 MMTCO$_2$ by 2020
12.3 MMTCO$_2$ by 2030

Oregon's Renewable Electricity Standard (RES) requires all utilities in the state to sell an increasing amount of clean, renewable energy. The largest utilities must sell 5 percent renewable electricity in 2011, increasing to 15 percent in 2015, 20 percent in 2020, and 25 percent in 2025.[67] Utilities with sales equal to between 1.5 and 3 percent of Oregon's total retail electric sales must meet a 10 percent requirement by 2025 and smaller utilities must sell 5 percent renewable electricity by 2025. Overall, in 2025, 20.5 percent of the state's electricity will come from renewable sources.[68]

Qualifying renewables include wind, solar photovoltaic or solar thermal, geothermal, landfill gas, tidal power, and biomass. Hydropower is eligible under limited circumstances. This increased renewable electricity generation is assumed to reduce the need for electricity from polluting sources, predominantly coal but also natural gas.

Government Energy Use

Projected Savings:
3.1 MMTCO$_2$ by 2020
4.2 MMTCO$_2$ by 2030

Reducing energy use in the government sector not only has a direct impact on global warming pollution, but it also sets an example for the private sector for what can be achieved. And given the recent volatility in energy prices, which has played havoc with government budgets, measures that improve energy efficiency and invest in renewable energy are not only good for the environment, but they also represent good fiscal stewardship for the taxpayers of Oregon.

Oregon state government has begun pursuing several measures to reduce its consumption of energy and contribution to global warming. Key components include:

- Constructing new state buildings and major renovations to exceed the energy conservation mandates in the state's building code by 20 percent or more.[69]

- Installing solar energy technology on all new or renovated publicly-owned buildings. Legislation passed in 2007 requires all public entities to spend 1.5 percent of a project's total contract price on solar energy technology.[70]

Governor Ted Kulongoski has also laid out strong greenhouse-gas reduction goals for Oregon's state agencies, calling on them to:

- **Reduce state government energy consumption by 20 percent from 2000 levels by 2015.**[71] Agencies are individually responsible for achieving these reductions. As of 2005, four agencies had already achieved a 20 percent reduction in electricity use and 10 others had cut consumption by 10 percent or more.[72]

- **Use an increasing amount of ethanol and biodiesel in the**

publicly owned vehicle fleet.[73] Because ethanol does not always have reduced global warming emissions compared to gasoline, this ethanol requirement does not necessarily result in reduced pollution. In this report, we assume no net increase or decrease from this requirement.

- **Draw 100 percent of state government electricity from renewable sources by 2010.**[74] Each state agency is responsible for setting its own targets to reach this goal. However, progress has stalled over questions on the legality of mandating state agencies to pay above-market prices for energy.

Municipal governments in Oregon also have committed to important measures. Portland, for example, requires all newly constructed city buildings to meet the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Gold standard, making them 30 percent more energy-efficient than buildings constructed to state code.[75] Additionally, the city requires all buildings that it owns or occupies to meet the LEED Silver standard.[76]

The global warming pollution reduction of 3.1 $MMTCO_2$ by 2020 includes benefits from just improved electric and natural gas energy efficiency. The use of ethanol and biodiesel and the requirement to increase renewable electricity use are not included.

Policies to Reduce Vehicle-Miles of Travel

Reducing and managing the number of vehicle-miles traveled in the state is a key element of minimizing Oregon's contribution to global warming. A strong statewide land-use planning program has helped to reduce driving, as has a commute-trip reduction program. Separately, the Portland metropolitan area has implemented the land-use planning program very effectively, and also invested in transit and in making the city more bicycle-friendly, both of which help to reduce driving.

Oregon adopted land-use planning goals in 1973. Cities and counties must adopt comprehensive growth plans that are consistent with state goals and update their zoning ordinances to match the plans.[77] One of the hallmarks of Oregon's land use planning guidelines is strong urban growth boundaries, which offer a clear demarcation between areas intended to be kept rural and those that can be developed more densely. These clear urban boundaries have helped to foster more compact development and increase the number of neighborhoods where residents do not have to depend solely on cars for transportation.

The Employee Commute Options (ECO) program, enacted in 2001, requires employers with more than 100 employees at one site to encourage their workers to reduce drive-alone commuting. For workers, the program often results in incentives for using public transit, carpooling, biking or walking to work, or the use of alternative work schedules or telecommuting. The ECO program offers advice to business owners, who are also eligible to receive tax credits for adopting specific commute-trip reduction measures.[78] The program reduces commute-trip miles by an estimated 40 million miles annually.[79]

The existing program provides a valuable framework for a broader effort to reduce high-emission commuting and could be strengthened by expanding it to more counties and to more employers, and by increasing state resources available for implementing and overseeing the program. Potential improvements to the program are discussed in greater detail later.

Investments in transit—particularly in the Portland region—and efforts to limit some sprawling growth have also helped to dampen the number of miles driven by Oregonians. The global warming emission savings from these efforts are incorporated into the baseline. Further savings are possible and are discussed later.

Portland has adopted a number of policies to encourage compact, walkable development near transit stations, enabling more commuters to get to and from work without using a car. That, combined with overall transit improvements, led to a 41 percent increase in transit ridership from 1998 to 2007.[80] Better facilities for cyclists have helped double the number of commuters who bike to work over the past decade.[81]

Projected Total Emissions with Existing Policies: Oregon Will Likely Meet its 2010 Goal and Is Halfway to its 2020 Goal

The policies that Oregon has already adopted will reduce global warming pollution by 3.5 $MMTCO_2$ by 2010, 16.0 $MMTCO_2$ by 2020 and by 19.3 $MMTCO_2$ by 2030. That means:

- Oregon's current policies should enable the state to meet its 2010 goal of arresting growth in global warming pollution.
- Oregon's current policies move the state 63 percent of the way to its emissions reduction target for 2020 of cutting emissions by 27 percent below 2005 levels.
- Oregon's current policies move the state 39 percent of the way toward its 2030 target. (The 2030 target is based on the assumption that the state will reduce emissions on a steady trajectory from 2020 to its 2050 target.)

Strategies to Further Reduce Global Warming Emissions

The policies that the state has already adopted will cut emissions from all sectors of the economy, but Oregon will need to do more to reduce its overall emissions. The strategies listed below are the next ones that Oregon should pursue to reduce global warming emissions.

Transportation Sector Strategies

1. Reduce vehicle travel through mileage-based insurance, an expanded commute-trip reduction program, smart growth and expanded transportation choices.

2. Establish a low-carbon fuel standard.

3. Reduce heavy-duty diesel truck fuel use.

Strategy #1: Reduce Vehicle Travel

Potential Savings:
2.3 MMTCO_2 by 2020
3.8 MMTCO_2 by 2030

Oregon's long-term global warming strategy for the transportation sector must reduce the number of vehicle-miles traveled (VMT). Emissions from transportation, which currently account for 40 percent of Oregon's carbon dioxide pollution, can be reduced through three complementary approaches: improving vehicle efficiency (such as with stronger fuel economy standards for cars and trucks), using fuels that release less global warming pollution, and reducing vehicle travel.

Using all three approaches makes cutting emissions easier. For example, a car that is 25 percent more efficient, replaces 25 percent of its fuel with alternatives, and is driven 25 percent fewer miles will consume 58 percent less oil. To obtain the same total reduction without reducing miles of travel would require a 35 percent cut in the carbon-intensity of fuels and a 35 percent improvement in vehicle efficiency—both of which are possible, but more difficult to achieve. Thus, cutting VMT is an indispensable part of meeting the state's global warming targets.

Oregon has made important progress in this direction. For decades, VMT increased as a result of population growth, low gasoline prices, expansion of the workforce, and commercial and residential suburban sprawl. Between 2005 and 2006, however, Oregon succeeded in halting VMT growth and in 2007, VMT declined by 0.5 percent from 2006 levels.[82] Now the challenge is to go beyond holding VMT steady and to begin to reduce driving.

Reducing VMT will be challenging, but success would bring benefits not only in reducing global warming pollution but also in easing traffic congestion, reducing public expenditures on highways, enhancing Oregon's energy security, and lowering automotive emissions of other pollutants that harm public health. Oregon's population is projected to increase by about 1.4 million residents from 2000 to 2030 (an increase of 41 percent), creating challenges to any effort to reduce driving.[83]

In 1991, the state's Transportation Planning Rule (TPR) mandated that Oregon's metropolitan areas reduce VMT per capita by 10 percent within 20 years, and by 20 percent within 30 years after adopting a transportation system plan.[84] These goals, however, have been modified over time. Today, metropolitan areas are required to submit plans for increased transit use and zoning changes, but do not have specific goals for decreasing VMT.

Oregon should establish a statewide vehicle-miles traveled (VMT) reduction goal and track the state's progress toward this goal. Oregon should commit to reducing its VMT by 10 percent from current levels by the year 2030. Given the state's projected population growth, that's equal to a 33 percent reduction in per capita VMT. This decline in driving would result in a 3.8 $MMTCO_2$ emission reduction.

Cities and states achieve VMT reductions when people get out of their cars and use alternative means of transit. Good strategies for reducing VMT make this happen in multiple ways:

- by providing frequent, convenient and consistent transit that takes people where they need to go.

- by decreasing the distance between sites that Oregonians visit repeatedly, such as work, school, stores, entertainment venues and civic buildings.

- by creating incentives for people to drive less, such as making the cost of driving more apparent.

- by reducing the need to drive alone to work.

Expand Transportation Choices

Without improved transportation choices, few drivers will be able to reduce how much or how far they drive. Oregon should take the following steps to enable residents to get to work, complete errands or reach entertainment venues without driving.

- **Expand and improve existing rail and bus transit systems in mid- to large-sized communities.** The Portland metro area has made a good start on transit, but more remains to be done. Existing service in Portland and in other urban areas should be expanded to meet the needs of more customers. In the Portland metro area, for example, most commuters travel to destinations other than downtown Portland.[85] Improved transit service in all parts of the metro area, including a network of frequent-service transit lines serving the suburbs, is one step toward providing better commuter service. The Lane Transit District has begun offering bus rapid-transit service as a reliable and affordable high-speed travel option for Eugene.[86] Transit agencies around the state can grow ridership by ensuring that transit is convenient, reliable and clean. All these steps will require additional resources for Oregon's cash-strapped transit providers, which under Oregon's constitution are ineligible for revenue from taxes on vehicle fuel, ownership or use.

- **Establish or expand bus service in smaller communities.** Most Oregonians are not well served by public transit. Establishing bus service in smaller and mid-sized communities will not only help reduce driving but will also foster more compact development patterns, as discussed further below.

- **Improve pedestrian infrastructure.** For a transit system to be successful, people need to be able to walk safely and easily to and from transit stations and bus stops. Communities should build sidewalks on both sides of the street, provide adequate lighting, install crosswalks at frequent intervals (and provide adequate enforcement of pedestrian right-of-way), and tailor the design of residential and commercial neighborhoods to be welcoming on a pedestrian scale.

- **Continue to make cities more bicycle friendly.** Better infrastructure—including well-maintained on-street bike lanes, bicycle prioritization at traffic lights, secure parking, and even bicycle- and pedestrian-only boulevards—can encourage more travel by bicycle. Driver and police education of the rights of cyclists and employer-provided showering facilities can also support cycling.

- **Invest in an inter-city rail and bus system.** Passenger rail service along the I-5 corridor should be more frequent, faster, and more reliable. Oregon should develop expanded bus service connecting smaller communities, including outside the I-5 corridor, similar to Washington's system. Portland's train station is served by local bus and rail; other rail stops should have similar transit connections, allowing rail passengers to make their entire trip without driving.

In conjunction with the other policies discussed here, improved transportation options will help Oregonians drive less.

Strengthen Land-Use and Transportation Planning

Oregon has a strong track record of encouraging compact development, but could do more. Instituted in the 1970s, the state's land-use planning program created a national model for setting limits on sprawling development and fostering smarter, more compact growth. Zoning codes in cities such as Portland and Salem incorporate transit-oriented development and encourage mixed commercial and residential development.[87]

But, with large population growth projected, more must be done to achieve Oregon's global warming goals. Oregonians must again act proactively to update land-use programs and plan for the future. Oregon has begun to re-examine its land use and planning laws through the Big Look Task Force on Land Use Planning. That process has already identified global warming as a key issue that must be incorporated into the land use planning process.

First and foremost, Oregon should incorporate consideration of global warming impacts into systems for land-use and transportation planning, and require that local land-use and transportation plans be consistent with global warming pollution reduction targets. Because Oregon already has statewide rules governing how local jurisdictions plan for land use and transportation, the state does not need a new planning system. Rather, the state should add consideration of global warming impacts to existing planning processes. Local land-use and transportation plans should comply with global warming pollution reduction goals.

Some of the steps that the state will need to take to incorporate its global warming goals into land use and transportation planning include:

- **Establishing "walkability" targets for all cities with populations over 40,000.** Just as the state needs a measurable target for clean transportation, Oregon also needs a goal for smart planning practices, such as mixed-use development and transit-oriented development. Already used in many Oregon cities, both practices work to create urban communities that are walkable rather than sprawling. When shops, restaurants, and homes are placed in the same neighborhood and are served by transit, residents can complete more trips and errands without using a car. To help quantify global warming progress made by city planning measures, Oregon should establish walkability targets for all cities with populations over 40,000, which would include Portland, Salem, Eugene, Gresham, Hillsboro, Beaverton, Bend, Medford, Springfield, Corvallis, Tigard, and Albany.[88]

- **Developing plans for new development that are consistent with global warming pollution reduction goals.** Mixed-use development patterns help reduce global warming emissions by removing the need for automobiles for local and short-distance uses. Oregon should require Metro, other metropolitan planning organizations, cities, and counties to adopt comprehensive plans, transportation investment plans and zoning that meet both VMT-reduction goals and global warming pollution-reduction targets. Regional plans should be integrated with local land use plans. The Land Conservation and Development Commission and the Oregon Transportation Commission should develop standards and planning tools and provide funding grants to help local governments create effective plans.

- **Establishing infill development requirements that communities must meet before expanding their urban growth boundaries.** Cities should consider redevelopment of existing buildings and construction on vacant lots, both of which are more likely to help create walkable neighborhoods than development on the urban fringe. Urban growth boundary expansions should occur only if infill and redevelopment targets that raise the average density of the town have been met.

Expand Mileage-Based Insurance

Shifting the calculation of automobile insurance rates from an annual rate (regardless of the number of miles driven) to a rate based on the number of miles driven—in addition to the typical risk factors—would encourage car owners to drive fewer miles and reduce global warming pollution.

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

One measure that is strongly linked to

driving safety and yet is not used with much accuracy in the calculation of insurance rates is travel mileage. Common sense, academic research and real world experience suggest that drivers who log more miles behind the wheel are more likely to get in an accident than those whose vehicles rarely leave the driveway.[89] Many insurers do provide low-mileage discounts to drivers, but these discounts are often small, and do not vary based on small variations in mileage. For example, a discount for vehicles that are driven less than 7,500 miles per year does little to encourage those who drive significantly more or less than 7,500 miles per year to alter their driving behavior. As a result, the system fails to effectively encourage drivers to reduce their risk by driving less.

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

A pay-as-you-drive (PAYD) system of insurance in Oregon might work this way: vehicle insurance could be split between those components in which risk is directly related to the ownership of a vehicle (comprehensive) and those in which risk is related to mileage (collision, liability). The former could be charged to consumers on an annual basis, as is done currently. The latter types of insurance could be sold in chunks of mileage—for example 1,500 miles—or be sold annually with the adjustments of premiums based on actual mileage taking place at the end of the year. Of critical importance to the success of the system would be the creation of accurate, convenient methods of taking odometer readings and communicating them to the insurer.

A PAYD system of insurance would have broad benefits for Oregon—not only for reducing global warming pollution, but also for improving highway safety and reducing insurance claims. Because insurers would still be permitted to adjust their per-mile rates based on other risk factors, mileage-based insurance would add additional costs for the worst drivers, giving them a financial incentive to drive sparingly.

Most importantly, research indicates that a mileage-based insurance system would reduce driving. Converting the average collision and liability insurance policy to a per-mile basis in Oregon would lead to an average insurance charge of about 6 cents per mile.[90] (For comparison, a driver buying gasoline at $3.00 per gallon for a 20 MPG car pays 15 cents per mile for fuel.)

If 80 percent of collision and liability insurance were to be assessed by the mile, the impact on vehicle travel would be significant, reducing vehicle-miles traveled by nearly 3 percent below projected levels, with carbon dioxide emissions from light-duty vehicles declining by roughly the same amount.

While many insurers remain resistant to the administrative changes that would be needed to implement mileage-based insurance, the concept is beginning to make inroads. In 2003, the Oregon Legislature adopted legislation to provide a $100 per policy tax credit to insurers who offer PAYD options, though as of early 2007, no company had begun offering PAYD insurance.[91] The Progressive auto insurance company has offered a pilot PAYD insurance system in Oregon and two other states, and is now offering PAYD insurance in more states.[92]

Oregon should consider moving toward a system of PAYD insurance for all drivers, perhaps by first requiring insurers to offer it as an alternative to traditional insurance. If the concept proves successful, the state (or insurers) could then require liability and collision rates to be expressed in cents-per-mile—thus maximizing the carbon dioxide emission reductions and other positive results of the policy.

Strengthen the Commute-Trip Reduction Program

While some Oregon employers have done an excellent job helping their employees reduce the number of miles they drive to get to work, the state's commute-trip reduction requirement does not go far enough—and has been recently weakened.

Commutes to and from work make up a major share of vehicle travel in Oregon. Nationally, about 27 percent of all vehicle miles are traveled on the way to or from work.[93] And, according to the 2000 U.S. Census, 73 percent of Oregonian workers age 16 and over drive to work alone.[94] Programs that require employers to facilitate and encourage transportation alternatives (such as carpools and use of public transit) to their employees can go a long way toward reducing the number of vehicle-miles traveled on Oregon's highways.

Oregon's Employee Commute Options (ECO) program, enacted in 2001, establishes a goal that employers will reduce trip rates by 10 percent from a 1996 baseline. However, employers who fail to meet the target must simply submit a plan for achieving reductions, and receive no penalty for falling short of the ECO goal. So far, just one-third of employers have met their goal.[95] The program applies exclusively to the greater Portland area. While Clackamas, Multnomah and Washington counties comprise 43 percent of Oregon's population, other major urban areas such as Bend-Redmond, Corvallis-Albany, Eugene-Springfield, Medford-Ashland and Salem-Keizer should be included in commute-trip reduction programs.[96] Moreover, a 2007 decision to raise the ECO program participation threshold from 50 on-site employees to 100 was a move in the wrong direction.[97] While the 2007 ECO changes also included improved accountability, Oregon should expand its commute-trip reduction efforts, not curtail them.

The ECO program could be made more effective by:

- Amending and expanding the program to include all employers with 50 or more full-time employees at a single worksite;

- Increasing the commute-trip reduction target for all employers with 50 or more full-time employees at a single worksite to 20 percent by 2020 and 30 percent by 2030;

- Applying ECO program standards to small employers at a single site with more than 50 employees, such as at a shopping mall with multiple stores, or an office complex with multiple small employers;

- Instituting programs to encourage and help employers of all sizes facilitate telecommuting and, where appropriate, provide shuttle service to nearby transit stations;

- Helping all employers establish flexible work schedules that allow workers to commute fewer days of the week by training managers on how to evaluate which positions are easily amenable to telecommuting and on supervising staff who telecommute;

- Funding additional ECO staff

positions to accommodate the increased workload.

Commute-trip reduction has proven to be an extremely cost-effective way to reduce highway congestion, energy use and air pollution. Washington State's $2.7 million annual investment (for program management, support for employers, technical assistance, marketing and policy development) has delivered more than $37 million in reduced fuel expenditures and travel delay alone.[98] Oregon should invest in its commute-trip reduction program not only to reduce global warming pollution, but also to reap more of the economic benefits associated with getting more cars off the road.

Adopt Other Policies to Reduce Driving

The state should consider what other policies might be adopted to support the creation of walkable communities and reduce driving. Possibilities include:

- **Location-efficient mortgages:** Require financial institutions to consider household transportation expenses when evaluating a residential borrower's ability to pay for a mortgage. Residential borrowers who live in walkable and transit-friendly communities spend less on transportation. These borrowers can afford to spend more on housing and should be eligible for larger home loans. Similarly, commercial borrowers located in transit-friendly, mixed-use projects spend less money providing and maintaining parking facilities and thus can pay for a larger loan. Such a policy should make walkable communities more financially attractive to buyers.

- **Congestion pricing:** Higher fees levied on drivers during peak travel hours can encourage motorists to use transit instead, if good alternatives are available. Adding new lanes to a roadway and assessing negligible congestion fees will not be adequate to help the state reduce its global warming pollution.

By focusing on the development of vibrant, compact communities whose residents have access to a variety of convenient, affordable transportation options, and by encouraging residents to drive less, Oregon can reduce the growth of vehicle travel, cutting emissions, reducing congestion on the state's highways, and curbing dependence on oil.

Strategy #2: Adopt a Low Carbon Fuel Standard

Potential Savings:
2.1 MMTCO$_2$ by 2020
4.5 MMTCO$_2$ by 2030

In 2007, Oregon passed a law establishing a renewable-fuel content requirement for gasoline and diesel, contingent upon in-state and regional biofuels production levels.[99] However, Oregon's 2007 law does not establish targets for how those fuels should help to reduce global warming pollution. The renewable fuel standard alone does not necessarily encourage the use of fuels with the lowest life-cycle global warming emissions.

The global warming emissions of ethanol and biodiesel depend on many factors, including how the feedstock (such as corn) is produced, how far it is transported, how it is refined, how refining byproducts are used, and how global land-use patterns change in response to greater use of corn and soybeans for fuel. These global land use changes are significant: full life-cycle emissions from corn ethanol may be twice as high as gasoline when global land-use impacts in response to rising food prices are taken into account.[100] As more corn in the U.S. is diverted from the food supply to produce ethanol, farmers here and abroad respond by clearing and cultivating more land, releasing carbon stored in the soil and in forests. The same series of land use changes can cause the life-cycle global warming emissions from soybean-based biodiesel to be at least 50 percent higher than conventional diesel.[101]

To avoid replacing gasoline and diesel with more polluting fuels, Oregon should adopt a low-carbon fuel standard, which would require that increasing amounts of fuel sold in Oregon come from sources with lower life-cycle global warming emissions than gasoline or diesel. The standard should require that by 2020, life-cycle global warming pollution from passenger vehicle fuels should be reduced by 10 percent per mile. By 2030, pollution should be reduced by 20 percent.

Fuels with lower life-cycle carbon emissions than gasoline and diesel include cellulosic ethanol made from crop waste or prairie grass grown on abandoned or marginal cropland and biodiesel produced from waste cooking oil. Electricity and hydrogen also can have lower life-cycle emissions than gasoline, especially if renewable energy is used to generate power and to produce hydrogen fuel. Technological and infrastructure hurdles must be solved before these fuels are widely used.

Most vehicles on the road today are capable of using only limited amounts of low-carbon fuels. Gasoline blended with a low percentage of ethanol can be burned in any vehicle, but higher blends, such as an 85 percent ethanol/15 percent gasoline mix, require an engine with a few simple modifications.

No mass-marketed vehicles are capable of using an external electricity supply. Plug-in hybrid cars have not yet been commercialized, but automakers are demonstrating the feasibility of these technologies through small-scale trials. Both General Motors and Toyota have committed to production of plug-in hybrids by 2010.[102] A low-carbon fuel standard would encourage development of less polluting fuels, the vehicles that use them, and a new fuel distribution infrastructure. Fuel distributors and sellers could invest directly in lower-emission fuels and infrastructure or could buy credits from electric utilities that sell electricity as a transportation fuel.

California recently adopted a low-carbon fuel standard that will cut global warming pollution from passenger vehicles fuels by 10 percent per mile by 2020.[103] Because the replacement fuels will be less polluting than gasoline but will not be zero carbon, the state expects that the standard will replace 20 percent of the state's gasoline consumption with lower-carbon fuels.[104]

As Oregon implements a low-carbon fuel standard, it is important that the state make policy decisions that maximize the benefits of the standard and limit environmental hazards. The state should ensure that implementation of the fuel standard does not adversely affect air quality or stress water resources.

Strategy #3: Reduce Heavy-Duty Diesel Truck Fuel Use

Potential Savings:
0.7 MMTCO_2 by 2020
2.9 MMTCO_2 by 2030

Heavy-duty trucks are major consumers of fuel. Large tractor-trailers consumed about 14 percent of the fuel used by all highway vehicles nationally in 2004, and fuel consumption by large trucks has been increasing by 2.1 percent per year from 1995 to 2005.[105] As is the case with the light-duty vehicle fleet, fuel economy among the largest trucks has also been declining, dropping 5 percent between 1997 and 2002.[106]

Heavy-duty trucks currently are exempt from federal fuel economy standards, but that should change in coming years. The federal Energy Independence and Security Act of 2007 requires a study of potential improvements in heavy-duty truck fuel economy and the adoption of fuel-economy standards for those vehicles. However, Oregon does not have to wait for the federal government to establish fuel economy standards in order to begin to reduce global warming pollution from heavy-duty diesel trucks.

Specific requirements to reduce rolling resistance and improve aerodynamics of heavy-duty diesel trucks can cut their global warming pollution. California has proposed several measures to cut emissions from heavy diesel trucks used for hauling goods long distances. The proposed requirements include the use of low rolling-resistance tires, skirts along the sides of trailers and aerodynamic fairings on the top of truck cabs and at the back of the trailers to cut wind resistance and turbulence.[107] Energy-efficient tires can cut fuel use by 1.5 percent, aerodynamic improvements to trailers can cut fuel use by 5 percent, and upgrades to the cab can provide additional savings. By investing $7,000 to $9,000 in better aerodynamics and reduced rolling resistance tires, a truck owner can cut fuel use and thus global warming emissions by 8 percent to 11 percent. The avoided cost of fuel means that the upgrades pay for themselves in two years.[108]

Already, some trucking companies and drivers in Oregon have implemented measures to improve the efficiency of their trucks. Cascade Sierra Solutions, a non-profit organization, offers loans, grants and tax credit assistance to help owners of heavy-duty diesel trucks used for long hauls to retrofit their vehicles for improved fuel economy and reduced global warming pollution.[109]

Oregon could adopt standards similar to California's and cut emissions from regulated heavy-duty diesel trucks by at least 8 percent by 2014. Simultaneously, Oregon should engage as an active participant in the federal regulatory process and recommend that the federal government establish the strongest possible fuel economy standards for diesel trucks.

A 2004 study conducted by the American Council for an Energy-Efficient Economy (ACEEE) found significant increases in fuel economy for these trucks are possible at a net lifetime savings to vehicle owners. Specifically, the study found that tractor-trailers could cost-effectively achieve a 58 percent improvement in fuel economy and identified cost-effective improvements in fuel economy for other types of large trucks.[110]

Imposing federal standards designed to increase the fuel economy of diesel trucks over 10,000 pounds by 50 percent would significantly reduce global warming pollution from the fast-growing freight transportation sector. The increase would be sufficient to raise the average fuel economy of heavy-duty trucks from approximately 5.8 MPG today to about 11.4 MPG in 2030.

Our estimated savings assume that Oregon adopts the California measures to retrofit existing trucks and that the federal government establishes fuel economy standards to cut emissions from new vehicles. There is no guarantee, however, that the federal government will establish such strong fuel economy standards for heavy-duty trucks, so strong input from states that are leaders on global warming will be important.

Residential, Commercial and Industrial Sector Strategies

4. Expand Energy Efficiency Programs
5. Improve Building Energy Codes in New Homes and Businesses

Strategy #4: Expand Energy Efficiency Programs

Projected Savings:
3.9 MMTCO$_2$ by 2020
4.7 MMTCO$_2$ by 2030

While Oregon has significantly improved its energy efficiency, major energy savings opportunities remain.

- A 2006 report for the Energy Trust found that—with better and deeper measures—Oregon can achieve cumulative savings of 590 average megawatts of electricity and 106 million therms of natural gas by 2017, nearly double the current electricity savings target for 2012 and 50 percent higher than the natural gas target.[111]

- The Northwest Power and Conservation Council, which develops and regularly updates an electricity plan for Oregon, Washington, Idaho and Montana, estimates that the region has at least 2,800 average MW of cost-effective energy efficiency potential by 2025. Based on Oregon's share of the region's population, that equals efficiency potential of 834 average MW by 2025, 40 percent above the savings identified for the Energy Trust by 2017.

- Preliminary estimates by the Northwest Power and Conservation Council for its next regional electricity plan suggest that the amount of cost-effective energy efficiency might be twice as great as identified in the current plan. With the adoption of a strong carbon cap and the sale of pollution permits, cost-effective energy efficiency potential could as much as triple.[112] Potential savings are available in every sector. The 2006 report for the Energy Trust found that more than 40 percent of electric efficiency potential is in the industrial sector, 40 percent is commercial, and 19 percent is residential. In natural gas, 45 percent of potential savings are in the commercial sector, while the remaining 55 percent of potential savings lie in the residential sector.[113]

To achieve these energy efficiency savings, Oregon should:

- **Raise statewide efficiency goals.** While Oregon's current efficiency goals are some of the best in the nation, they could and should be better still. The Energy Trust has demonstrated its ability to exceed its current efficiency targets and it is clear that the state has much more energy efficiency potential. Oregon should adopt a goal of obtaining 1,600 average MW of energy efficiency by 2025, the state's share of the regional efficiency potential estimated by the Northwest Power and Conservation Council.

- **Ensure adequate funding to achieve these higher goals.** Customers of all electric and natural gas utilities should be included in energy efficiency goals and should contribute funding at the same rate for such programs.

- **Require the industrial sector to meet and provide funding for efficiency goals.** In 2005, Oregon industries consumed 38.5 percent of non-transportation energy in the state, more than either the residential sector (34.7 percent) or the commercial sector (26.7 percent).[114] Large industrial energy users in Oregon are not subject to the same energy efficiency targets as the residential and commercial sectors. However, as the 2006 Energy Trust report reveals, 41 percent of potential electricity savings lie in industry.[115] Oregon should include the industrial sector when establishing new statewide efficiency standards. Furthermore, industrial energy users should pay for energy efficiency programs just as other users do. An additional step that the state could take to identify energy efficiency opportunities is to require a time-of-sale energy audit of existing buildings. The additional information will allow buyers to make better decisions. The state could even require that large, inefficient commercial buildings be renovated and made more energy-efficient.

Our estimate of the global warming pollution reduction that could be obtained with energy efficiency assumes that the state captures 1,600 average MW of energy savings by 2025 (the state's share of the regional efficiency potential estimated by the Northwest Power and Conservation Council) and that the reductions occur across the residential, commercial and industrial sectors.

Strategy #5: Improve Building Energy Codes for New Homes and Businesses

Projected Savings:
5.2 MMTCO_2 by 2020
16.7 MMTCO_2 by 2030

Oregon already has adopted the nation's strongest energy codes for new homes, but by strengthening residential and commercial codes further, the state could obtain even greater reductions in global warming pollution.[116]

Oregon has long been a leader on building codes and should continue in that role by regularly updating its building codes to reduce electricity and natural gas use in new buildings consistent with achieving zero net fossil energy use by 2030. Such buildings are efficient enough that their energy requirements can be satisfied with renewable energy sources, such as passive solar heating, design that permits extensive use of natural light, solar hot water heating, solar panels to generate electricity, and geothermal heat pumps for cooling and heating.

The American Institute of Architects, the U.S. Conference of Mayors, and the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), whose building codes are widely adopted, have all endorsed a goal of net zero energy buildings by 2030.[117] The California Public Utility Commission has set a goal of net zero energy codes for all new residences by 2020, and all new commercial buildings by 2030.[118] Net zero energy use by 2030 is a strong but reachable goal that Oregon should adopt.

We assume that new commercial buildings are built to an energy code that becomes progressively more stringent from 2010 so that commercial structures built in 2030 have zero net energy use. The efficiency of new homes improves consistently beginning in 2012. Because commercial buildings are relatively short-lived and are rebuilt more often than homes, the improvement in commercial building codes has a particularly rapid impact.

Electric Sector Strategies

In addition to efforts to conserve electricity, Oregon can also reduce carbon dioxide emissions from electricity use by making electricity generation in Oregon cleaner—specifically by limiting construction of new polluting power plants.

Strategy #6: Limit Emissions from New Coal-Fired Power Plants

Projected Savings:
4.7 MMTCO_2 by 2020
13.4 MMTCO_2 by 2030

Emissions from electricity consumed by Oregonians is the largest source of global warming pollution in the state, primarily due to fossil-fueled generating plants outside of Oregon that export electricity into the state. Without clear policies to reduce global warming pollution, imported power is projected by the federal Energy Information Administration to become much more polluting as power companies build new coal-fired power plants. Stopping the growth in emissions from coal-fired electricity generation is crucial if Oregon is to reduce its contribution to global warming.

Two approaches are available to Oregon to avoid increasing emissions from coal-fired power plants. The first option is to adopt a generation performance standard, which establishes a maximum amount of global warming pollution that can be released from generating a megawatt-hour of electricity. The standard should apply to both power generated in Oregon and power generated elsewhere for consumption in Oregon. The second approach is a strong economy-wide cap on global warming pollution.

Adoption of the other policies identified in this report that reduce electricity use and increase renewable electricity generation will be essential to helping Oregon meet its energy needs while complying with a generation performance standard. A generation performance standard helps to ensure the greatest emission reductions from those policies.

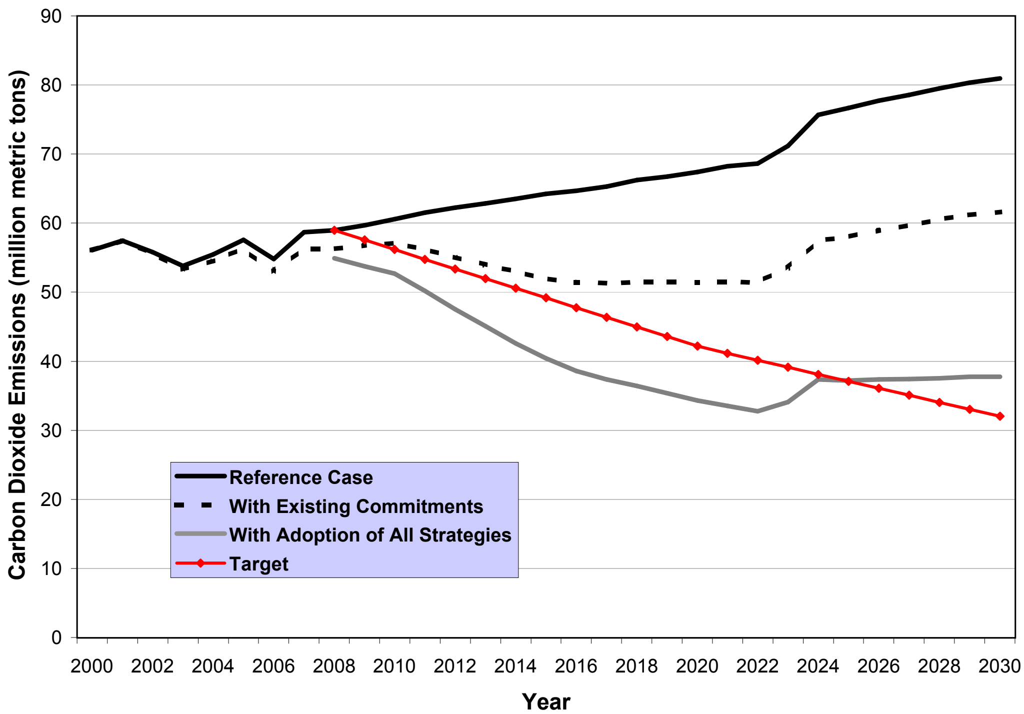
Washington, for example, has a generation performance standard that requires that new electric generating resources produce global warming pollution at a rate no higher than an average new natural gas combined-cycle combustion turbine, or 1,100 pounds of carbon dioxide per megawatt-hour, whichever is less.[119] Beginning in 2008, utilities are not allowed to enter into new long-term financial commitments with a power generator that fails to meet the generation performance standard.[120]

Oregon may not need to adopt a generation performance standard if the state adopts a strong and binding cap on global warming pollution that applies to electric utilities. Such a cap could take the form of the cap-and-trade program being developed by the Western Climate Initiative, a regional effort that includes Oregon, Washington, Montana, California, Arizona, New Mexico, Utah and three Canadian provinces. A strong commitment by these states, many of which are home to power plants that sell electricity to Oregon utilities, to reduce global warming pollution should preclude construction of new coal-fired power plants.

Projected Total Emissions with Additional Policies

The strategies listed above outline a path that would lead to significant reductions in carbon dioxide emissions in Oregon. We estimate that the specific strategies listed above would reduce Oregon's global warming emissions by 40 percent below 2005 levels in 2020, allowing the state to surpass its 2020 emission reduction goal of cutting pollution by 27 percent below 2005 levels, despite increases in population and economic activity. However, by 2030, the policies modeled in this report will be inadequate to allow the state to achieve its targeted emission reductions and Oregon would be 88 percent of the way to its emission reduction target. (See Figure 7.) By adopting these six key policies in addition to the strong steps that the state has already taken, Oregon can close the gap to its first major pollution-reduction milestone. To achieve its 2030 and later goals, the state will need to develop further strategies.

Figure 7. Projected Carbon Dioxide Emissions in Oregon with Recommended Strategies



The Need for Further Reductions

Oregon has already begun to implement a variety of pollution-reduction strategies that have the state well on its way to stabilizing its global warming emissions. Adopting a handful of new policies to supplement the strategies that Oregon already has in place will allow the state to lower its global warming emissions well below 2005 levels by 2020. Despite its progress thus far, Oregon cannot afford to become complacent.

As mentioned earlier, staving off the worst impacts of global warming will require rapid action. If we are to have any hope of limiting future temperature increases to no more than 2° C (3.6° F), emissions of global warming pollutants must peak no later than 2015 and decline by 50 to 85 percent below 2000 levels by 2050.[121]

To ensure that Oregon achieves these long-term reduction goals and that the entire region is on a path to similar reductions, Oregon should take several steps.

Adopt an Economy-Wide Cap on Global Warming Pollution

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

Adopting an economy-wide cap on emissions would:

1. Allow policy-makers to set enforceable targets for global warming emissions that are consistent with the latest climate science.

2. Prevent increases in global warming emissions from activities other than

energy use (such as methane emissions from landfills) and from portions of the economy that are not covered by specific clean energy policies.

3. If structured as part of a cap-and-trade program, allow for global warming pollution reductions to come from the portions of the economy where they can be achieved at the lowest cost.

In 2006, the state of California adopted the nation's first statewide cap on global warming emissions, requiring emissions to be reduced to 1990 levels by 2020. New Jersey, Hawaii and Connecticut have since adopted similar caps. Oregon should follow suit.

Oregon will need to pursue additional policies to reduce emissions after 2020 if it is to obtain sufficient emission reductions in 2030 and beyond. Oregon should grant state agencies the authority to implement measures that will help meet the cap.

The strategies presented in this report are not the only ones that have the potential to reduce global warming emissions in Oregon. Indeed, the strategies listed above fall short on several fronts. They leave some major sources of energy-related global warming pollution—including air travel, bunker fuels, industrial energy use, and emissions of non-carbon dioxide global warming pollutants—virtually untouched. And the policies do not address non-energy emissions, such as from some forestry practices, farming, waste management and land use. To reduce emissions to the level that scientists say is necessary to avoid the worst impacts of global warming, Oregon will need to develop effective strategies for stemming the growth of emissions from all sectors of the economy.

Continue to Support a Strong Regional Cap on Pollution

Second, Oregon has an important leadership role to play in regional discussions of climate policy. An effective regional policy will help ensure the integrity of emission reductions within the state.

Oregon participates in the Western Climate Initiative (WCI), a regional effort that includes Oregon, six other states and four Canadian provinces that have agreed to reduce their global warming pollution by 15 percent by 2020 and have called for a regional cap-and-trade system on global warming pollution.[122]

To achieve the reductions mandated by the cap, participating states will need to adopt policies to reduce emissions at the state and local level, but should also be able to trade pollution credits across state lines. Oregon should urge states participating in the WCI to adopt meaningful state caps on pollution and push for strengthening the regional system. A regional cap-and-trade system should lower the costs of reducing emissions and facilitate reducing emissions from the electric sector.

Methodology and Technical Discussion

General Assumptions and Limitations

This report makes projections of Oregon's future emissions of carbon dioxide and provides estimates of the impacts of a variety of public policy strategies for addressing global warming.

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

First, we rely in part on energy consumption data and projections from the U.S. Energy Information Administration (EIA) to estimate past, present and future global warming emissions in Oregon. Emissions through 2005 (except in the electric sector) are based on state-specific EIA estimates of energy consumption in Oregon. Emissions for 2006 and future years in the residential, commercial, industrial and transportation sectors are based on projected rates of growth in energy use for the Pacific region (which includes Washington along with Oregon, California, Alaska and Hawaii) adjusted to reflect Oregon's population growth, job creation rate and driving patterns versus the region as a whole. Specific conditions in Oregon may be different than those in the region as a whole. Future projections of energy use depend on a range of assumptions as to the price and availability of various sources of energy and energy-consuming technologies. Thus, the projections should be viewed as one possible scenario for the future, though other scenarios are certainly possible.

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

All fees, charges and other monetary values are 2007 dollars, unless otherwise noted.

Historic Emissions Estimates

All non-electric estimates are based on Oregon's fossil fuel consumption data (in BTU) through 2005 from U.S. Department of Energy, Energy Information Administration (EIA), *State Energy Consumption, Price and Expenditure Estimates*, 29 February 2008. Electric sector fuel consumption for 2001 through 2006 is based on electricity mix fuel data provided by Phil Carver, Oregon Department of Energy, personal communication, 10 June 2008. Data for 2006 included cogeneration, which was split proportionately between coal, natural gas, distillate fuel and biomass. Fuel mix for 2000 was calculated as the average of 2001 to 2006, multiplied by electricity consumption. For 1990, we calculated the fuel mix based on the Western Electricity Coordinating Council average for 11 western states (obtained from EIA), multiplied by electricity consumption in Oregon. This approach for calculating 1990 emissions is the same as that used in Governor's Advisory Group on Global Warming, *Oregon Strategy for Greenhouse Gas Reductions*, December 2004.

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

Adjustments to Energy Consumption Data

Ethanol

EIA state energy data for gasoline consumption include ethanol used as a blending component. EIA assumes that ethanol produces no net emissions of carbon dioxide. To adjust for the fact that ethanol is included in the gasoline figure but does not have the same global warming emissions, we calculated the percentage of ethanol used in motor gasoline by volume in 1990-2005 using EIA state energy data. We then reduced consumption of motor gasoline (in BTU) by this percentage.

Adjustments Not Made

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

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

Adjustments for Non-Fuel Use

Many fossil energy sources are also used for non-fuel purposes (for example, petrochemicals used in the manufacture of plastics or natural gas used in the production of fertilizer). Energy sources used for non-fuel purposes emit carbon dioxide at different rates than those used as fuels. To account for this, we calculated or obtained the percentage of various energy products used for non-fuel purposes and accounted for the percentage of carbon that is "sequestered" (not emitted) from those uses.

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

Exceptions to this are as follows:

- For non-fuel use of distillate and residual fuel oil and liquefied petroleum gases from 2001-2004, we determined that the data on non-fuel energy consumption provided in *Documentation 2004* were likely in error. As a result, we used values from *Documentation 2003* instead.

- For non-fuel use of natural gas, we assumed (per *Documentation 2004*) that non-fuel use of natural gas for the production of nitrogenous fertilizers was a non-sequestering use (i.e., that all of the carbon in the natural gas is emitted). For the sake of simplicity, we treated use of natural gas in fertilizer production in the same manner as we did use of natural gas for energy purposes. Because a breakout for other non-fuel uses of natural gas was not available in *Documentation 2001*, we calculated this figure for 1990 and 2000 based on data from *Documentation 2000.*

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

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

Carbon Coefficients and Emission Factors

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

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

We did not incorporate emissions from natural gas flaring or emissions from geothermal energy sources in this analysis. Combustion of wood and biomass was excluded from the analysis per EIA, *Documentation.* The exclusion of wood and biomass is justified by EIA on the grounds that wood and other biofuels obtain carbon through atmospheric uptake and that their combustion does not cause a net increase or decrease in the overall carbon "budget." EIA assigns a carbon coefficient to municipal solid waste, but for the purposes of this report we do not calculate any emissions from waste. Separate data on combustion of waste versus wood and other biomass for electricity are not available for every year. In the years for which data on waste combustion are available, it represents just one quarter of one percent of electricity generation, so we believe that ignoring emissions from waste introduces little error.

Future Year Projections

Projections of energy use and carbon dioxide emissions for Oregon are generally based on applying the Pacific region year-to-year projected growth rate for each fuel in each sector from EIA's *Annual Energy Outlook 2008 (AEO 2008)* to the Oregon baseline emissions estimate for 2005 (or 2006 for electricity). Because Oregon's population (and presumably its economic activity) is projected to increase first slower and then faster than the Pacific region as a whole, we multiplied the year-by-year growth rate from *AEO 2008* by the ratio between the projected population growth rate in Oregon (from the U.S. Census Bureau), and the regional population growth rate.

We made several exceptions to this:

In the commercial sector, we adjusted the regional annual growth rate using projected employment growth rates for Oregon. Projected employment growth rates provided in Oregon Employment Department, *Forecasters Expect Slow Growth but Many Job Openings* (press release), 28 November 2007, continued only until 2016. We assumed that employment growth rates remained stable after that.

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

In the transportation sector, we made two adjustments to project future gasoline and ethanol use. First, we used Oregon-specific projections of VMT to estimate total gasoline and ethanol consumption, assuming the same improvements in fuel economy standards as implied by EIA's data. We assumed that VMT increases by an average of 1.35 percent per year, per Oregon Department of Transportation, *Oregon Transportation Plan Update: Final Technical Memorandum*, *Mode Growth Forecasts Subtask 2C(c)*, 2 February 2005. Though there has been a slight decline in VMT since the publication of this report, we feel this estimate is reasonable, for two reasons. First, a more current projection of VMT on state-owned highways shows slightly higher growth. That projection was provided by Christina McDaniel-Wilson, Transportation Analyst, Oregon Department of Transportation, personal communication, 2 May 2008. Second, the forecast in the *Transportation Plan* assumes that VMT per capita is basically stable and that VMT increases at the rate of population growth. Projections of population growth by the state and by the U.S. Census Bureau show slightly lower growth than 1.35 percent per year. Thus, we concluded that 1.35 percent was neither overly aggressive nor overly conservative.

After calculating total gasoline and ethanol use, we then adjusted the split between ethanol and gasoline to account for the biofuels requirements of the 2007 federal Energy Independence and Security Act. We determined that EIA's data on ethanol use in the Pacific region contained an error, so we relied upon the national data in *AEO 2008* for how much ethanol use will increase. *AEO 2008* includes low-level blends of ethanol in the motor gasoline category, while EIA's *State Energy Consumption, Price and Expenditure Estimate*s do not. We adjusted the ethanol and gasoline estimates in *AEO 2008* for this difference before applying the changing national ratio of ethanol to gasoline to Oregon's total use of ethanol and gasoline.

Carbon Dioxide Reductions from Electricity Savings and Renewable Energy Use

The electricity produced in Oregon is much lower emission than the electricity consumed in the state, so we use a "consumption-based" approach to calculating electric-sector emissions instead of the production-based approach as in other sectors.

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

Net electricity generation from each type of fuel was estimated by multiplying consumption of each fuel for electricity generation to meet Oregon demand by the average heat rate of generators using that fuel for the Western Electricity Coordinating Council-Northwest Power Pool (of which Oregon is a part). Heat rates for fossil fuel-fired power plants were calculated by dividing the amount of each fuel consumed in the WECC region by the net generation from that fuel (with both figures coming from the supplementary tables to EIA's *AEO 2008*). For renewable electricity generation, the heat rate was assumed to be the average for fossil fuel power plants in the United States, per EIA, *State Energy Consumption, Price and Expenditure Estimates (SEDS), Technical Notes*, Appendix B, downloaded from www.eia.doe.gov/emeu/states/_seds_tech_notes.html, 3 April 2007.

Reduced electricity demand or increased renewable production was first assumed to reduce the need for new coal-fired generation built after 2008. If additional reductions were possible, we assumed they offset existing coal-fired capacity.

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

Emission Reductions from the Strategies

Commitments Already Made

Clean Cars Program

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

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

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

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

1. Estimating Vehicle-Miles Traveled by Age

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

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

To estimate the percentage of vehicle-miles traveled accounted for by cars and light-duty trucks, we relied on VMT splits by vehicle type for 2000 through 2005 from the Federal Highway Administration, *Highway Statistics* series of reports. We assume that this percentage does not change in coming years.

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

3. Estimating Carbon Dioxide Emissions With and Without the Standards

Baseline carbon dioxide emissions without the Clean Cars Program or the newly updated federal CAFE standards are based on assumptions about future vehicle fuel economy from EIA, *AEO 2007*. These fuel economy estimates were translated into per-mile carbon dioxide emission factors assuming that consumption of a gallon of gasoline produces 8,869 grams (19.6 pounds) of carbon dioxide. This figure is based on carbon coefficients and heat content data from U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2001*, Appendix B. Fuel economy estimates for years prior to 2003 were based on EPA laboratory fuel economy values from EPA, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2004*, April 2004. Both the EIA estimates of future fuel economy and the EPA estimates of historic fuel economy were multiplied by an "on-road degradation factor" (representing the degree by which real-world fuel economy falls below EPA laboratory results) from *AEO 2007*.

To calculate savings of the Clean Cars Program's global warming gas emission standards, we used data prepared for California Environmental Protection Agency, Air Resources Board, *Comparison of Greenhouse Gas Reductions for the United State and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations*, 25 February 2008. From the program's implementation in Oregon through 2020, we calculated the percentage reduction in emissions expected each year in California fleetwide for cars and the lightest light trucks, and fleetwide for heavier light trucks, under both the new federal CAFE standards and the Clean Cars Program. We then applied those percentage reductions to projected emissions from vehicles in Oregon and tallied emissions from all vehicles to create a fleetwide projection.

From 2021 through 2030, we assume that neither the CAFE standards nor California's greenhouse gas pollution standards change, but fleet emissions will continue to decline as old vehicles are replaced. We applied the percentage reduction in carbon dioxide emissions per mile from a 2002 baseline for each model year. After 2020, we assume that new vehicles maintain the same percentage reduction as in 2020. We then calculated fleetwide emission levels under the two scenarios.

Building Energy Codes

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

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

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

Energy savings from code improvements were based the assumption that Oregon's new residential code update produces a 15 percent reduction in natural gas and electricity use. Commercial code changes are in development and so no savings are assumed from the baseline.

Energy Efficiency and Appliance Standards

The Energy Trust of Oregon has reported the program's electricity and natural gas savings in Energy Trust of Oregon, *Board Briefing, True Up 2007: Tracking Estimate Corrections and True Up of 2002-2006 Savings and Generation*, 8 August 2007.

The Oregon Public Utilities Commission established an electricity efficiency target of 20 average megawatts (aMW) per year for the Energy Trust in 2006 and 2007, which the Energy Trust exceeded. From 2008 through 2020, we assume that the Energy Trust meets but does not exceed the PUC's target. We also included the projected energy efficiency savings proposed by PacifiCorp and PGE and approved by the PUC. PacifiCorp will fund 36 aMW of energy efficiency from 2008 to 2012, while PGE will fund 42 aMW, per memo from Lori Koho to the Public Utility Commission, *Portland General Electric: (Advice No. 07-25) Requests Approval for Incremental Energy Efficiency Funds*, 12 May 2008, and memo from Lori Koho, to the Public Utility Commission, *Pacific Power & Light: (Advice No. 07-022) Establishes Schedule 297, Energy Conservation Charge*, 15 January 2008.

Based on the ratio of aMW to kilowatt-hours (kWh) saved in the Energy Trust's first five years, we estimated that annual savings of 20 aMW equals 175 million kWh. We further assume that electricity savings implemented in any given year persist for 13 additional years, such that cumulative efficiency savings include the current year's investment plus the previous 13 years' savings, per Energy Trust of Oregon, *Approved 2008-2009 Action Plan*, 12 December 2007.

The Oregon Public Utilities Commission established a natural gas efficiency target of 700,000 therms for the Energy Trust in 2006 and 2007, which the Energy Trust exceeded. From 2008 through 2020, however, we assume that the Energy Trust meets but does not exceed the PUC's target. We assume that natural gas savings implemented in any given year persist for 20 additional years, per Energy Trust of Oregon, *Approved 2008-2009 Action Plan*, 12 December 2007.

Estimates of appliance efficiency savings for four appliances for which Oregon adopted efficiency standards were based on state-specific estimates for Oregon from the American Council for an Energy Efficient Economy (ACEEE) and Appliance Standards Awareness Project (ASAP) *Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards*, January 2005 and March 2006. Electricity savings were assumed to begin in 2007 or 2008, depending on the appliance. Standards related to lighting energy use were assumed to be covered under building codes for new buildings, and 30 percent of the savings from those measures were eliminated in order to avoid double-counting in the combined scenario case for policies already adopted. In the combined scenario case for all policies, appliance standards are already incorporated into the baseline estimate of energy use because the federal government adopted all but one standard nationally.

Renewable Electricity Standard

The renewable electricity standard establishes different renewable electricity requirements for utilities depending on how much power they sell. By 2025, adjusting for the load-dependent requirement of each utility, a total of 20.5 percent of all electricity sold in Oregon must come from renewable sources, per Bill Drumheller, Oregon Department of Energy, personal communication, 17 April 2008. This equals 82 percent of the 25 percent sales requirement of the largest utilities.

We assume that utilities linearly increase their sales of renewable electricity in the years between the benchmarks established in the renewable electricity standard. To adjust for the effect of the lower requirement of smaller utilities, we multiplied the requirement for the largest utilities by 0.82 in each year.

Government Energy Use

Baseline estimates of public sector energy consumption in government buildings in Oregon was estimated by dividing estimated energy consumption in government buildings by estimated energy use in all commercial buildings based on data from EIA, *2003 Commercial Buildings Energy Consumption Survey (CBECS)*. For electricity and natural gas, Pacific regional figures were used. The resulting percentage was then applied to Oregon commercial energy consumption in the reference case to arrive at an estimate of government building energy use in Oregon. Fuels not included in *CBECS* were assumed not to be used in Oregon government buildings.

To these baseline estimates of government energy use, we then applied a 10 percent reduction in government electricity use below 2001 phased in by 2008, and a total of a 20 percent reduction in electricity and natural gas use phased in from 2009 to 2015.

Additional Strategies

Reduce Vehicle Travel

Estimated carbon dioxide reductions from reduced growth in vehicle travel are based on the assumption that vehicle travel in Oregon is reduced by 10 percent below 2008 levels by 2030. This was compared to the gasoline consumption projection in the reference case to determine the percentage by which gasoline consumption would be reduced through slower growth in vehicle travel.

Low-Carbon Fuel Standard
Estimates of emission reductions from the adoption of a low-carbon fuel standard are based on an assumption that Oregon will replace its biofuels mandate with a low-carbon fuels requirement. Beginning in 2011, we assume that the average carbon content of gasoline and diesel will decline by 1 percent each year to achieve a 10 percent reduction by 2020 and a 20 percent reduction by 2030.

Heavy-Duty Diesel Improvements
Baseline fuel economy estimates for medium- and heavy-duty diesel vehicles were obtained from *AEO 2008*. We modeled two programs that would reduce emissions from diesel vehicles.

First, we assumed that Oregon adopts California's proposed aerodynamic and rolling efficiency standards. The California Air Resources Board, in *Proposed Heavy-Duty Vehicle Greenhouse Gas Emission Reduction Regulations* (presentation at public workshops), June 2008, assumes that the improvements will cut fuel use and thus emissions by 8 to 11 percent. To be conservative, we assume an 8 percent improvement. The standards apply to tractor-trailer combinations that are at least 53 feet long and that drive 50,000 miles per year or more. Using U.S. Census Bureau, 2002 Economic Census, *Vehicle Inventory and Use Survey*, *Geographic Series: Oregon*, December 2004, we estimated that regulated trucks account for 71 percent of miles traveled by heavy-duty diesel trucks in Oregon. From 2011 to 2013, only those vehicles in fleets of 20 or more trucks are subject to the regulation. Because no data on fleet size was available, we assumed that half of trucks were subject to the regulations during that period.

We applied savings from the California standards to existing vehicles. For new vehicles, we assumed that federal fuel economy standards equivalent to a 50 percent increase in miles-per-gallon fuel economy would be phased in linearly beginning in 2015 and ending in 2025.

Fuel economy improvements were assumed to penetrate the vehicle fleet according to VMT accumulation by vehicle age estimates from U.S. Census Bureau, *2002 Economic Census: Vehicle Inventory and Use Survey*, December 2004. Fuel consumption per mile for vehicles of each model year was then multiplied by the percentage of VMT traveled in vehicles of each model year, and then summed across model years to arrive at an estimate of fleetwide fuel economy after imposition of fuel economy standards.

The fleet fuel economy estimates for medium- and heavy-duty trucks were then divided by the average medium- and heavy-duty fleet fuel economy baselines to arrive at a percentage reduction in fuel consumption per mile driven. A weighted average reduction was calculated and then applied to estimates of diesel use by medium- and heavy-duty trucks in order to obtain an estimate of the percentage of transportation diesel use remaining.

Residential, Commercial and Industrial Sector Strategies

Expanded Energy Efficiency Goals
Increased energy efficiency targets for electricity and natural gas are based on estimates by the Northwest Power and Conservation Council. We began with the estimate of regional cost-effective energy efficiency potential provided in the Northwest Power and Conservation Council, *Fifth Power Plan*, May 2005, and assigned approximately 30 percent of that potential to Oregon, based on Oregon's share of the region's population. Using data provided

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We assume that natural gas energy efficiency potential is the same as that identified in Stellar Processes and Ecotope, for the Energy Trust of Oregon, *Energy Efficiency and Conservation Measure Resource Assessment*, 4 May 2006. We assumed that increased natural gas savings are implemented at a constant rate beginning in 2009 and that after 2017 annual savings remain steady.

Building Energy Codes

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

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

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

Energy savings from code improvements were based the assumption that a new commercial code takes effect in 2010 that produces a 15 percent savings in energy use and that in 2012, Oregon establishes a code for residential and commercial buildings on a trajectory to zero net energy use by 2030.

Electric-Sector Strategies

Emissions Performance Standard for Electricity

We assume that the generation performance standard will prevent any expansion in coal-fired generation of electricity beginning in 2009.

Combined Policy Case

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

- The policy case does not include emission reductions from some appliances subject to both appliance efficiency standards and updated building codes.

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

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