Oregon Strategy for Greenhouse Gas Reductions

Governor's Advisory Group On Global Warming

State of Oregon, December 2004

Governor's Advisory Group On Global Warming

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The Oregon Department of Energy published this report on behalf of the Advisory Group.

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State of Oregon, December 2004

Oregon Strategy for Greenhouse Gas Emissions
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For copies of the report, see
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Executive Summary

Global warming is not just another environmental issue.

It's not "just another issue," period.

Absent decisive actions across the globe of the sort proposed in this report, the warming already underway is expected to lead to changes in the earth's physical and biological systems that would be extremely adverse to human beings, their communities, economies and cultures. These are changes that we would have unintentionally brought upon ourselves, but that are also in our power to reverse. Our failure to return atmospheric accumulations of greenhouse gases (GHG) back to levels that will sustain historic climate patterns may lead to an Earth that is dramatically altered and far less habitable within only a few generations.

The impacts of such changes on Oregon citizens, businesses and environmental values are likely to be extensive and destructive. Coastal and river flooding, snowpack declines, lower summer river flows, impacts to farm and forest productivity, energy cost increases, public health effects, and increased pressures on many fish and wildlife species are some of the effects anticipated by scientists at Oregon and Washington universities.

The means to arrest and reverse these effects are at hand or within technological reach. Many of them carry co-benefits that would justify acting on them without the impetus of global warming: positive economic returns on dollars invested in energy efficiency, energy price stability, and healthier air and water. Others will cost us something up front for insurance against the deeply disruptive and costly effects that we can expect absent any action. The earlier we take many of these actions, the less drastic they will have to be to achieve the same emissions reduction result.

The Governor's Advisory Group on Global Warming developed this *Oregon Strategy for Greenhouse Gas Reduction.*[1] Governor Ted Kulongoski appointed the Advisory Group early in 2004 to perform this task. This Strategy, if implemented, will complement the agenda of the West Coast Governors' Global Warming Initiative undertaken by the governors of California, Oregon and Washington to address greenhouse gas emissions at a state and regional level.

The Problem

Several thousand of the earth's scientists worked together on the Intergovernmental Panel on Climate Change to review the exhaustive evidence and describe the plausible range of outcomes. They agree that global warming caused by greenhouse gas pollution from human activities represents a profoundly serious threat to human civilization and to even the most robust and insulated natural ecosystems. Their comments are echoed in the *Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest* prepared by scientists at Oregon and Washington universities in the fall of 2004 following a thorough regional review of the science (Appendix C).

[1] The Advisory Group and its 2004 process are described in greater detail below.

Oregon Choices

As Oregonians and Americans, we clearly have choices about how we will respond to the warming of our planet. We can choose a "business as usual" path of contributing ever-increasing greenhouse gas emissions to already high atmospheric concentrations. But if we choose "business as usual," we leave a legacy for our children and grandchildren of a changing global climate that threatens human habitation and biological ecosystems. The costs to adapt to and remedy these changes will be much higher than they would be if we act today.

Alternately, we can adopt the goals and the set of actions recommended in this report to arrest and reverse Oregon's contribution to these global warming trends. In doing so, we will set ourselves on a path to reduce emissions over time and stabilize the global climate conditions we bequeath to our children.

Goals

The Advisory Group believes that setting goals for Oregon, expressed together with actions that can plausibly meet those goals over time, gives purpose and structure to the task of reducing greenhouse gas emissions. The Advisory Group proposes the following new goals:

1. By 2010, arrest the growth of Oregon's greenhouse gas emissions (including, but not limited to CO_2) and begin to reduce them, making measurable progress toward meeting the existing benchmark for CO_2 of not exceeding 1990 levels.
2. By 2020, achieve a 10 percent reduction below 1990 greenhouse gas levels.
3. By 2050, achieve a "climate stabilization" emissions level at least 75 percent below 1990 levels.

The goals offer a pathway to climate stabilization that requires vigorous action, but also allows time for necessary individual and business adjustments.

Economic Investments and Opportunities

In any discussion of addressing global warming, it's easy to get trapped in the underbrush of near-term costs and to miss the forest of rational economic calculation of long-term savings. In some cases those near-term costs are going to be higher, but often the costs will be matched by the returns that Oregon families and businesses will see directly.[2]

The economic dimension of dealing with climate change can be stated as a series of "costs," but it can also be stated in a more affirmative way. Many actions proposed in this report carry price tags, but they are generally in the nature of investments that can generate net economic returns to us over time. Most are investments we are experienced in making, from improving the efficiency of our homes, farms, factories and appliances to developing non-polluting new energy sources such as wind, solar, agricultural biomass and other renewable resources. These should remind us of our long investment in hydroelectricity.

[2] The effects of global warming on Oregonians and the costs we will bear in adapting to climate change are not just a function of what we do in one state. They also depend on the degree to which our leadership and actions are matched by leadership and actions across the country and around the globe.

Near-term costs are further offset by helping Oregon businesses stay *competitive* in a world moving to greenhouse gas limits. Costs of recommended actions should also be measured against the *economic opportunities* that will open for Oregon businesses that develop goods and services for sale to a world in the market for low greenhouse gas solutions.

Other costs are similar to buying insurance policies against events that would otherwise cost far more to cope with. Avoiding the potentially destructive storms, floods and forest fires that are projected to accompany global warming would likely be less costly than the repairs we would need to make following such events. These measures will bring the same welcome returns that past investments in flood control have earned.

We believe there will be many economic opportunities for companies and communities that rise to the challenge by developing the practices and technology products that our trading partners in other states and countries also will need to cope. We have ample experience in Oregon with this outcome. Many companies here have built prosperous business lines in energy efficiency products and consulting practices, in developing renewable energy technologies and adapting the power system for optimal use. We believe Oregon's entrepreneurs, supported by Oregon's academic and technical capabilities, can prosper by positioning themselves at the leading edge of change.

Principles and Strategies

The set of principles the Advisory Group used to guide its efforts placed primary emphasis on real, measurable and meaningful reductions in the state's greenhouse gas emissions. The Advisory Group also emphasized the need to focus first on the most cost-effective actions and those that create investment and entrepreneurial opportunities. We agreed we would not take actions that could impair reliability in our electrical and other energy supply systems, and we believe that many of our recommendations will actually enhance this quality.

The principles create the right direction and focus for Oregon. The Strategy further articulates four broad strategies that complement the principles:

1. Invest in energy, land use and materials efficiency.
2. Replace greenhouse gas-emitting energy resources with cleaner technologies.
3. Increase biological sequestration (farm and forest carbon capture and storage).
4. Promote and support education, research and technology development.

Recommended Actions

The Advisory Group has recommended a set of actions – some very specific, others more in the nature of shifting Oregon's long-term policy orientation – that collectively will meet our first goal of reversing the upward trend of Oregon's greenhouse gas emissions. The list of actions we choose or must take over the next fifty years is far from complete, since many needed actions and opportunities will only reveal themselves as we proceed. New, more cost-effective technologies and applications will emerge. Improved scientific understanding will open new doors.

The Strategy recommends actions in seven areas as outlined in Part Two:

(1) Integrating Actions
(2) Energy Efficiency
(3) Electric Generation and Supply
(4) Transportation
(5) Biological Sequestration;
(6) Materials Use, Recovery and Waste Disposal
(7) State Government Operations

Within these areas, the Advisory Group identified two categories of actions.[3]

Category I: Significant Actions for Immediate State Action
These actions promise significant greenhouse gas savings, are technically feasible today and are often the most cost-effective first actions to be taken.

Category II: Other Immediate Actions
These actions make sense for Oregon to undertake immediately. In most cases the greenhouse gas savings are less significant, but costs are also proportionately lower and many actions are cost-effective now.

Accomplishing Category I actions will usually require the most concerted and disciplined effort on the part of Oregonians. Equally meaningful progress toward the proposed goals will be extremely difficult to achieve without substantially achieving most or all Category I actions.

Some of the major Category I actions include:

Integrating Actions (IA-1): Arrest the growth of and begin to reduce Oregon's greenhouse gas emissions by 2010. Meet a goal of 10 percent below 1990 Oregon emissions levels by 2020 and at least 75 percent below 1990 levels by 2050.

Energy Efficiency (EE-1): Meet Oregon's energy efficiency target set by the Northwest Power and Conservation Council for the next 20 years, capturing at least 960 average megawatts of electricity savings and comparable conservation of natural gas and oil.

Electric Generation and Supply (GEN-1): Increase the renewable content of electricity.

Electric Generation and Supply (GEN-2): Recommend that the Governor create a special interim task force to examine the feasibility of, and develop a design for, a load-based greenhouse gas allowance standard.

[3] The Advisory Group considered Category III Actions that, for various reasons including manageability of the process, it chose to defer. As these and other possible actions are proposed, they can be developed and considered by a successor to this Advisory Group.

Transportation (TRAN-1): Convene an interim task force to recommend a proposal for the Environmental Quality Commission or the Governor and the Legislature to adopt greenhouse gas emission standards for vehicles.

Materials Use, Recovery and Waste Disposal (MW-1): Achieve the waste disposal and recovery goals already adopted by Oregon in statute.

Of the 19 Category I actions, two are constrained by law to be cost-effective. The Northwest Power and Conservation Council's 20-year energy efficiency goals (incorporated in action EE-1) must meet a test, established in federal law, of being cost-effective to the region (and in nearly all cases, to individual electricity consumers). The California state law establishing the "Pavley" auto tailpipe pollution standards (TRAN-1) requires that new cars be able to meet the twin tests of low greenhouse gas emissions and cost-effectiveness to the purchaser.

The other Category I action with the greatest potential for cost consequences is the proposed greenhouse gas allowance for electricity, gas and oil (GEN-2). Estimating the costs and benefits of this measure depends on its design, on future energy markets and costs, on technology evolution and on future regulatory actions. We can model different paths to our greenhouse gas content (also referred to as "carbon content") goal and select one that offers the greatest greenhouse gas savings at the lowest cost and risk. By relying on energy efficiency and renewable technologies that are unaffected by fossil fuel markets and price swings, compliance actions can minimize abrupt rate shocks to consumers and cost impacts that could undermine the competitiveness of Oregon businesses.

An effective design may maximize the ability to trade emissions savings and offsets with California and Washington, lowering compliance costs. The design of a greenhouse gas allowance mechanism can be made sensitive to competitive pressures on Oregon businesses if other states and countries are not pursuing parallel paths to greenhouse gas reductions.

There are also 27 Category II recommendations in Part Two. Although individually smaller, these actions add up to significant reductions. All actions combined could result in reversing the continued growth of greenhouse gas emissions generated from Oregon and set the state on a path of declining emissions. However, if we continue "business as usual," by 2025 Oregon's greenhouse gas emissions would be 61 percent higher than 1990 levels (today they are 15 percent higher). On the other hand, if we accomplish reductions from all the actions recommended in the report, our emissions would only be 7 percent higher than they were in 1990 and, trending downward, consistent with the Advisory Group's recommended 2020 goal.

In addition to overseeing the implementation of the recommendations, there is a next set of tasks for the Governor's next Advisory Group – further development of some of the more complex recommendations. This new group must also consider what Oregon must do to adapt to the unavoidable warming conditions from greenhouse gas emissions that have already accumulated over the past centuries.

Oregon's Role

The key to stabilizing CO_2 concentrations is limiting total world emissions for the 21st century. What should be Oregon's "share" of this global responsibility?

We are a small state, but part of a country that is the world's largest consumer of fossil fuels and emitter of greenhouse gases. Both U.S. and Oregon emissions are growing rapidly. Oregon total greenhouse gas emissions in 2000 were about 68 million metric tons of carbon dioxide equivalent.[4] About 84 percent of Oregon's greenhouse gas pollution comes from CO_2 emissions directly. Emissions from methane, primarily from cattle and landfills, contribute 7 percent of greenhouse gas pollution; nitrous oxide emissions, primarily from agricultural practices, contribute about 6 percent to the state's greenhouse gas pollution. Manufactured halocarbons, which include hydrofluorocarbons, perfluorocarbons and suflurhexafluoride, account for the remaining 3 percent.

We recognize that Oregon's contribution to both the problem and its solution is a small part of the whole. We can't succeed without complementary activity on the part of states and nations whose emissions dwarf our own.

Fortunately, many countries that have ratified the Kyoto Protocol and other U.S. states are embarking on their responsibilities in parallel with Oregon. For example, the agreement reached among the three governors of Oregon, Washington and California, who joined to form the West Coast Governors' Initiative on Global Warming, means the West Coast states will proceed in parallel and sometimes joint efforts. We also have other partners in the six New England states and five eastern Canadian Provinces that form the Conference of New England Governors and Eastern Canadian Premiers, who have committed to a regional "Climate Change Action Plan." In addition, Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont are designing a regional cap-and-trade system for carbon dioxide emission from power plants. Many of these states and Kyoto-signing countries are also our trading partners, so we may also be preserving access to these markets for Oregon's businesses.

The Advisory Group has made its recommendations based on detailed technical and policy analysis and a broad range of comments from citizens, businesses, academic institutions and other organizations. Now we must decide, as an Advisory Group, a Governor and a State, whether we are prepared to adopt the meaningful carbon reduction goals proposed and the actions that will be required to meet those goals. There couldn't be more of Oregon's future riding on the outcome.

[4] As a reference, Oregonians emitted almost 17 metric tons of CO_2 per capita, compared to a world wide average of about 4 metric tones. On this basis, Oregon is producing about four times its "share."

The Governor's Advisory Group on Global Warming

The Advisory Group is made up of citizens and public officials who were asked by Governor Kulongoski to serve for the limited duration necessary to draft a Global Warming Strategy. The Group's citizen members include representatives of the business community that both deliver and use energy, farmers, environmentalists, scientists and others (a list of members is included in Appendix A).

Individual members of the Group may have conflicts of interest with respect to many of the actions it considered. Such conflicts are inescapable given that the subject matter (energy production and consumption, transportation, waste generation and management, etc.) is integral to the lives and businesses of all Oregonians. Moreover, the Governor wanted citizens who would understand the science and the economic and technical issues involved, and who would be sensitive to the impacts to Oregonians of the actions being considered. State agencies (such as the Department of Environmental Quality) that are directed by independent state commissions (e.g., the Environmental Quality Commission) participated as ex officio members and any recommended actions are subject to subsequent commission policy determinations.

After reviewing public comments, the Advisory Group met to incorporate changes where appropriate and decide on final recommendations to the Governor and other appropriate parties. The Advisory Group reached consensus on the strategies and actions it chose to recommend and adopted these final recommendations unanimously.

Some recommendations emerged as state administrative actions, while others will still need legislative approval. Where there are fiscal or workload effects on state agencies, the Governor and agency heads will determine where these recommendations fit into priorities. The Advisory Group expects that more complex actions will require their own task forces to work out details for legislative consideration.

This report offers final recommendations to the Governor, to state agencies having statutory authority and to Oregonians generally. The Group is advisory only, and its recommendations will take effect only if state and local governments, private businesses and other organizations believe they merit adoption.

Advisory Group members would like to acknowledge the financial assistance provided by The Energy Foundation of San Francisco. This assistance made it possible for the Group to rely on the services of the National Policy Consensus Center and Oregon Consensus Program at Portland State University for logistical and facilitation support.

Part One


ODOT


ODOT


Ken Niles

Oregon Strategy for Greenhouse Gas Reductions

Report to the Governor

The Governor's Advisory Group on Global Warming — December 2004

"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities." (*Intergovernmental Panel on Climate Change [IPCC], Climate Change 2001: The Scientific Basis, Summary for Policymakers*, p. 5)

"Greenhouse gas forcing in the 21st century could set in motion large scale, high-impact, non-linear, and potentially abrupt changes in physical and biological systems over the coming decades to millennia …." (*IPCC 2001, Summary for Policymakers*, p. 14)

"Here in Oregon we're putting together a battle plan to reduce greenhouse gases – the primary cause of global warming . . . We are not going to wait for federal leadership. We've got too much to lose if global warming continues unabated. And we've got too much to gain by being a leader in climate solutions."

Governor Ted Kulongoski
May 4, 2004

SECTION 1

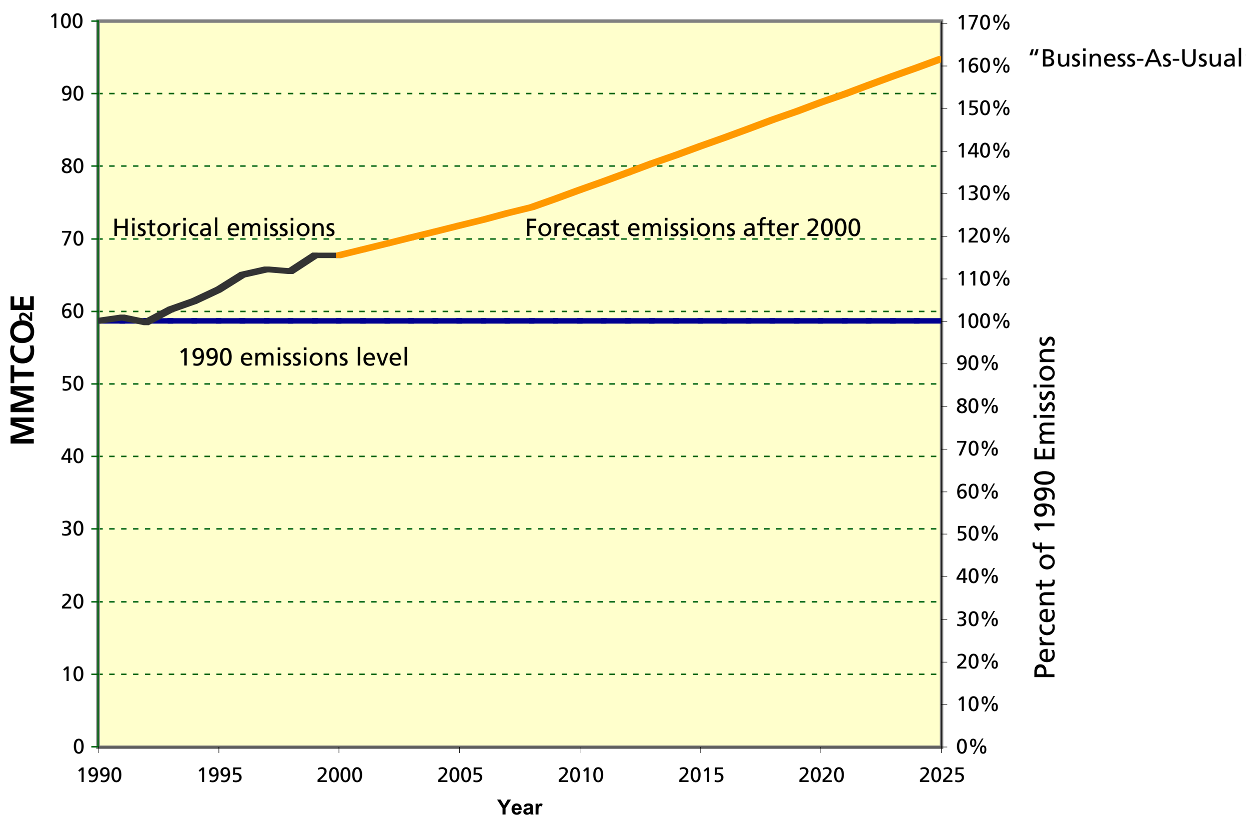
Introduction

Global warming is not just another environmental issue.

It's not "just another issue," period.

Absent decisive actions across the globe of the sort proposed in this report, the warming already underway is expected to lead to changes in the earth's physical and biological systems that would be extremely adverse to human beings, their communities, economies and cultures. These are changes that we would have unintentionally brought upon ourselves, but that are also in our power to reverse. Our failure to return atmospheric accumulations of greenhouse gases (GHG) back to levels that will sustain historic climate patterns may lead to an Earth that is dramatically altered and far less habitable within only a few generations. Figure 1 below shows historic and projected greenhouse gas emissions for Oregon.

FIGURE 1
Historic and Forecast Greenhouse Gas Emissions in Oregon



The black line that rises from 1990 to 2000 represents historical greenhouse gas emissions from Oregon. The orange line that continues beyond that represents a forecast of future emissions under a "business as usual" approach, which assumes we continue present activities (including many that now restrain greenhouse gas emissions), but take no additional special actions to reduce these emissions.

The vertical axis on the left is in million metric tons of carbon dioxide-equivalent (MMTCO$_2$E). "CO$_2$E" is the equivalent radiative impact of all the greenhouse gases expressed as tons of CO$_2$. It is larger than that of CO$_2$ alone, because it accounts for the radiative effects of other gases. The vertical axis on the right shows differences from 1990 levels, with 1990 representing 100 percent of emissions.

The impacts of such changes on Oregon citizens, businesses and environmental values are likely to be extensive and destructive. Coastal and river flooding, snowpack declines, lower summer river flows, impacts to farm and forest productivity, energy cost increases, public health effects, and increased pressures on many fish and wildlife species are some of the effects anticipated by scientists at Oregon and Washington universities.

The means to arrest and reverse these effects are at hand or within technological reach. Many of them carry co-benefits that would justify acting on them without the impetus of global warming:

positive economic returns on dollars invested in energy efficiency, energy price stability, and healthier air and water. Others will cost us something up front for insurance against the deeply disruptive and costly effects that we can expect absent any action. The earlier we take many of these actions, the less drastic they will have to be to achieve the same emissions reduction result.

But why is global warming an Oregon concern? We're one medium-sized state among 50 states and a world of nations, all emitting greenhouse gases. What can we do about it anyway? What do we stand to lose if we do nothing? What do we stand to lose – or gain – if we take the issue head-on?

These are the kinds of questions the Governor asked this Advisory Group on Global Warming to help answer, and this report is its response. It's far from a complete one. The choices made over many decades have led to the threat of global warming, and the solutions will take time and deliberate effort. There will be difficult choices along the way and surprising, promising opportunities as well. We will have the company of other knowledgeable and committed partners. And while the challenges are formidable, so are our skills and spirit and resourcefulness.

This report tries to answer the Governor's questions in stages. Part One, Section 2 (below) seeks to set out a pragmatic vision for how Oregon can address its global warming responsibilities and, in the process, seek investment and market opportunities for Oregon business and new jobs for Oregon workers. Section 2 also discusses proposed goals, categories of actions to achieve these goals and criteria for selecting actions. Section 3 sets out the scientific context for this response, while addressing the general "What is it?" and "What does it mean to me?" kinds of questions. The Advisory Group also reviewed the consequences for Oregon and Oregonians of a global failure to act decisively.

Part Two contains the detailed set of recommended actions. The Conclusion sums up the Advisory Group's proposition to Oregonians.

SECTION 2

Vision: Oregon Acts on Global Warming

2.1 Oregon's "Fair Share" of Global Greenhouse Has Emissions Reductions

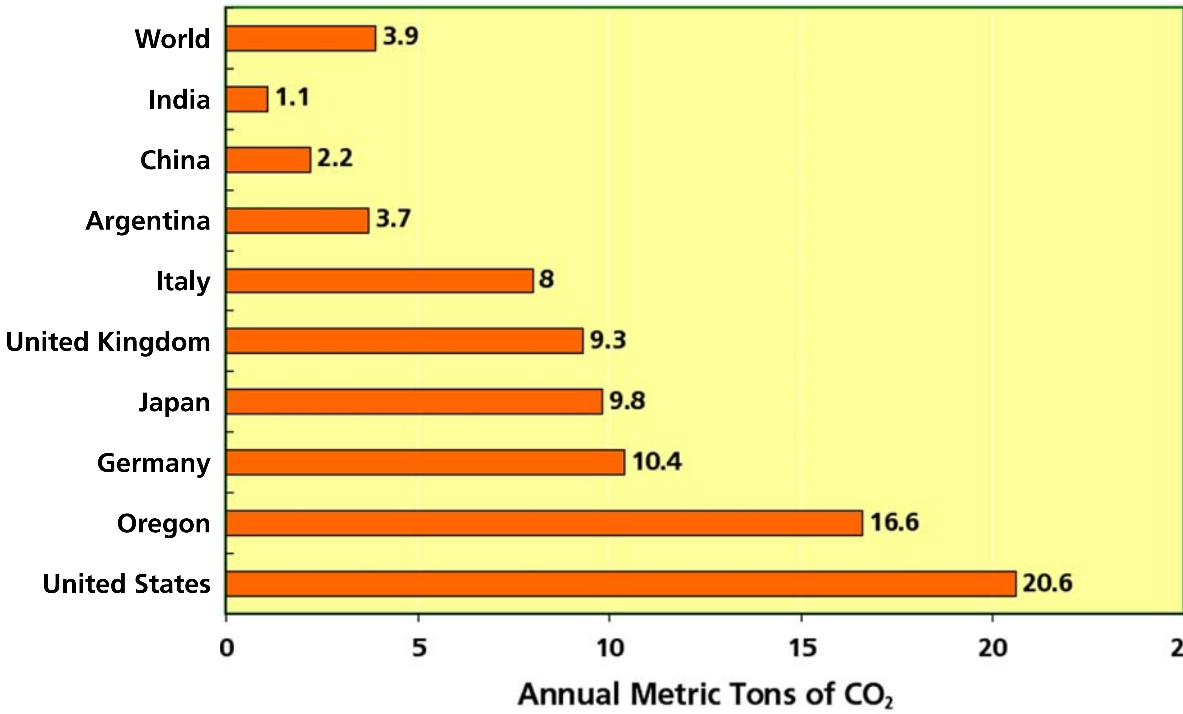
Scientists from the United Nations Intergovernmental Panel on Climate Change and others estimate that global CO_2 emissions need to be reduced by 60 to 80 percent below 1990 levels to avoid dangerous interference with the climate system. This target is based on limiting CO_2 to double the level that existed prior to 1750. Beyond this level, the risks of catastrophic climate change rise steeply. Serious adaptation actions will still be needed, even if emissions are held below this threshold.

The key to stabilizing CO_2 concentrations below this threshold is limiting total world emissions for the 21st century. What should be Oregon's "share" of this global responsibility? We are a small state, but are part of a country that is the world's largest consumer of fossil fuels and emitter of greenhouse gases. Both U.S. and Oregon emissions are growing rapidly.

Figure 2 below shows that Oregon has slightly lower CO_2 emissions per capita than the U.S. as a whole, largely due to our hydro-electric endowment. While about 43 percent of Oregon's electricity comes from carbon-free hydroelectricity, about 42 percent comes from the most carbon-intense source – coal (see Figure 6, Sec. 3.1). Oregon utilities are contemplating a mix of new resources (wind generation and gas- and coal-fired power plants) that is typical for U.S. utilities.

In 2002, electricity sources for the U.S. as a whole emitted 1.34 pounds of CO_2 per kWh. Oregon utilities emitted 1.05 pounds of CO_2 per kWh. Figure 2 also shows per capita CO_2 emissions from fossil fuels for the world as a whole and a sample of other countries. Oregonians emitted almost 17 metric tons of CO_2 per capita, compared to the worldwide average of about 4 metric tons. On this basis, Oregon is producing four times its "share."

FIGURE 2
CO_2 Emissions Per Capita From Fossil Fuels



Sources: United Nations, U.S. Department of Energy, Oregon Department of Energy

Other factors will play into global negotiations that will eventually have to allocate pollution rights and reduction obligations. It is unlikely, however, that in any such negotiations the United States and its constituent parts – the states – would be allocated any reduction target that is less than the worldwide average, given our higher than average per capita emissions. More likely, it would be some weighting of population, current emissions levels, cumulative greenhouse gas emissions and other factors.

Thus, a 2050 goal of reducing greenhouse gas emissions 75 percent below 1990 levels would likely be the least demanding target we might merit. We will likely be called upon to deliver more significant reductions than this, rather than less.

2.2 Principles

The Advisory Group began with the following principles to guide the selection of goals and actions to reduce Oregon's greenhouse gas emissions:

A. Oregon's greenhouse gas reduction goals and solutions must be meaningful, firmly grounded in science, and lead to effective reductions in Oregon's greenhouse gas emissions, commensurate with the state's share of the larger global problem.

B. Oregon should first begin with the most cost-effective solutions.

C. To the fullest extent possible, Oregon's actions should be designed to serve both the long-term economic well-being of the state and the goal of climate stabilization.

D. Recognizing that there are always tradeoffs between a long-term investment strategy and near-term costs and cash flow, the Advisory Group believes Oregon can and should be a leader – but the State can't get so far ahead that Oregon's businesses are not competitive in the short term. The State will need some safety valves to relieve short-term competitive pressures if others aren't living up to their responsibilities along with Oregon.

E. Oregon creates long-term economic well-being with an "investment strategy" that buys efficiency savings, new technologies, energy price stability and a competitive edge in marketing – and profiting from – the tools developed and the lessons learned.

F. Oregon will take no actions that impair energy reliability.

G. Oregon will look for ways to support innovation, especially if it leads to marketable products and services.

H. Oregon will partner with other states, Canadian provinces, tribal nations and other nations, where doing so will enhance the effectiveness of state-level actions and their co-benefits for Oregonians.

I. Reducing the state's greenhouse gas emissions won't eliminate the need to adapt to the warming climate that will result from changes already fixed in the atmosphere. Oregon must next develop an adaptation strategy.

J. Oregon is committed to equity in allocating both costs and benefits of this enterprise.

2.3 Goals, Strategies and Implementation

The package of actions recommended by the Advisory Group represents no more than a down payment on the long-term commitment the State – and nation – must make. Many other choices will be required of Oregonians and their successors over the next several decades to arrest and reverse the growth of greenhouse gas emissions that threaten our world. But isolated action, viewed out of context, will not persuade Oregonians to support the commitments and participate fully in implementing the actions, as they must, if we are to stabilize our climate at historically habitable levels.

The Advisory Group offers its recommendations embedded in a pragmatic vision of goals, ways and means. This vision statement may seem deceptively simple, but the Advisory Group believes it can serve to anchor the full range of its recommendations.

2.3.1 Goals

The Advisory Group believes that setting goals for Oregon, expressed together with actions that can plausibly meet those goals over time, gives purpose and structure to the task of reducing greenhouse gas emissions. The goals proposed here offer a pathway to climate stabilization that requires vigorous action, but also allows time for necessary individual and business adjustments. Oregon should adopt greenhouse gas emissions standards along with other states and local governments. A fuller discussion of the rationale for setting goals and for proposing these can be found in Integrating Action IA-1 in Part Two.

> **Near-term Goal**: The Advisory Group believes the State should first seek to meet its existing Benchmark #76, that CO_2 emissions not exceed 1990 levels. The Advisory Group recognizes that Oregon is unlikely to meet that benchmark by 2010 because Oregon exceeded the benchmark by 18 percent in 2000.
>
> In Integrating Action IA-1 (see Part Two), the Advisory Group recommends, as a near-term goal, that by 2010 Oregon will arrest the growth of and begin to reduce the state's total greenhouse gas emissions, meeting or making measurable progress toward meeting Oregon's current CO_2 benchmark.

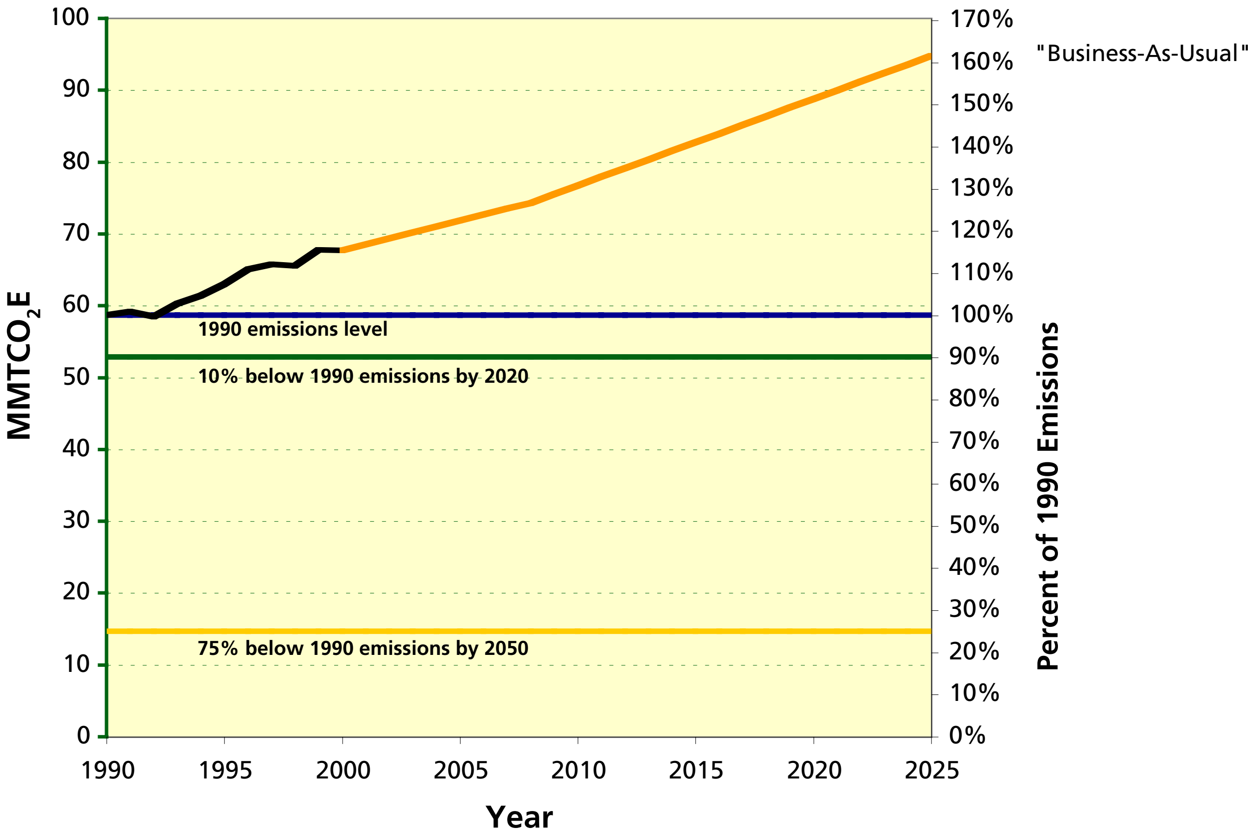
Based on current scientific guidance and targets adopted by other states and countries, the Advisory Group considers the following goals to be appropriate for Oregon:

> **Intermediate Goal:** By 2020, Oregon's total greenhouse gas emissions will not exceed a level 10 percent below 1990 levels.
>
> **Long-term Goal:** By 2050, Oregon's total greenhouse gas emissions will achieve a "climate stabilization" level at least 75 percent below 1990 levels.

The Intermediate and Long-term Goals are predicated on the United States government and the global community achieving comparable goals roughly synchronous with Oregon's efforts. Oregon can exercise leadership in setting goals and acting to attain them, understanding that leaders need followers (or, better yet, partners) to accomplish the global goal.

Having long-term goals will facilitate a long-term Oregon investment strategy to achieve those goals, rather than a series of short-term controls and costs (see Section 2.4, An "Investment-Based" Solutions Strategy, below). Figure 3 shows the projected emissions compared to the goals.

FIGURE 3
Historic and Forecast Gas Emissions in Oregon Showing Proposed Goals



Along with the historical and forecast emissions shown in Figure 1, the horizontal lines in Figure 3 above show the level of greenhouse gas emissions (a) in 1990, (b) at 10 percent below 1990 levels, and (c) at 75 percent below 1990 levels. These levels represent proposed goals for the State's strategy and provide a context for the reductions from the proposed actions. The 75 percent reduction of greenhouse gas emissions is what is required globally to stabilize atmospheric concentration of greenhouse gases at 550 parts per million (ppm) of carbon dioxide. Although double the pre-industrial concentration, this level is assumed to avoid serious climate impacts.

2.3.2 Strategies

Implementation of the Advisory Group's recommended actions will greatly reduce Oregon's greenhouse gas emissions. Collectively the actions can be summed up in the following four common sense strategies:

Strategy One: Invest in Energy, Land Use and Materials Efficiency
This is nothing new for Oregonians, who have often set the pace for the rest of the country in the efficient use of these commodities. Oregon's efficiency investments have almost always

generated positive economic returns, together with environmental and quality-of-life dividends. Some payouts are quick (e.g., energy-efficient appliances); others may generate returns over decades (e.g., "green" buildings and mass transit in urban areas).

Many investments of this type will also generate business opportunities as described below in Section 2.5: The Economics of Addressing Global Warming: Costs, Investments and Opportunities.

Over the next 20 years, Oregon must, at a minimum:

- Equal the electric energy conservation savings achieved over the last 20 years, about 1,000 average Megawatts (aMW).
- Achieve comparable efficiency savings among natural gas and oil users.
- Offer more convenient and more efficient transit and other alternatives to driving cars and trucks, principally in urban areas along the I-5 corridor. Those areas have the ability to reduce the number of vehicle miles traveled and trips taken through careful land use and transportation planning.
- Insist on products that: 1) use fewer materials and require less energy to produce and transport to market; 2) last longer; and 3) are designed to be reused and recycled more easily and completely using less energy.

Strategy Two: Replace Greenhouse Gas-Emitting Energy Technologies With Cleaner Technologies

This strategy calls for reducing the amount of conventional coal, oil and natural gas used in vehicles, homes and businesses unless technological means can be devised to lower their greenhouse gas emissions dramatically.

It requires focusing investment dollars (and government policies) on developing renewable generating technologies that today are not sufficiently advanced to take up the slack.

Higher marketplace costs of conventional, mostly fossil-fueled energy sources are already upon us and are stimulating research and development. But new and more effective government policies – such as greenhouse gas emissions allowances and trading mechanisms – will be needed to meet the proposed goals. No less critical will be government procurement policies that explicitly value low greenhouse gas content (also referred to as "carbon content"), thereby creating a base market for these resources and setting an example.

By using a variety of electric-hybrid and other technologies, Oregonians will have new gas and diesel cars and trucks that produce far less CO_2 per mile traveled than existing vehicles. The transportation sector may ultimately rely on electric or hydrogen-powered vehicles, but biofuels are available now and hold considerable near-term promise, not to mention economic opportunity for Oregon's farmers.

The fossil fuel industries are exploring geological greenhouse gas sequestration (capture and storage) that could ultimately have costs comparable to other mitigation technologies.

Strategy Three: Increase Biological Sequestration (farm and forest carbon capture and storage)
Oregon's fields and forests are valued by Oregonians for economic, environmental and recreational reasons, but they can and must perform an additional service. The Advisory Group recommends actions to increase the amount of carbon that can be captured and fixed in new or restored forest and field growth and in the soil beneath. Decades of clearing forests, turning the soil, and building cities and highways where there had been undisturbed ground have both released large quantities of greenhouse gases and impaired the land's physical ability to take up and sequester excess gases. While we will continue to work the lands that must feed, clothe and shelter us, there are still land management choices that will restore much of this natural sequestration capability. Reforestation and conservation reserves in lands of marginal economic value are familiar tools. These uses must be stepped up dramatically, encouraged and sustained with government policies and public investment dollars.

Strategy Four: Educate Citizens, Conduct Research and Develop Technology
Reversing the causes of global warming and adapting to its near-term effects will be multi-generational tasks for Oregonians. Success is more likely if succeeding generations of Oregonians are educated about causes and cures and how these will evolve over time. Oregon also will cope better if it enlists the expertise in its colleges and universities to educate citizens and to conduct research into impacts and remedies that also can produce marketable products and services. Developing electrical and mechanical engineering skills will be essential.

Oregon can benefit from taking the early initiative in addressing global warming with such tools. Economic and export opportunities may emerge, particularly in areas such as energy efficiency, small-scale distributed renewables, and bio-sequestration techniques, where techniques and smaller-scale technologies can have broad application with lower capital requirements. Developing good quality curricula on global warming for freshman physical science, chemistry and physics courses is also essential.

2.3.3 Implementation

The Advisory Group issued a *Draft Oregon Strategy for Greenhouse Gas Reductions* for public review on October 13, 2004. After three public meetings and a public comment period (October 13 through November 15, 2004) the Advisory Group revisited the draft recommendations in light of 250 public comments and modified them where appropriate.

The recommendations are now forwarded to the Governor and copied to the Sustainability Board, which can then offer its thoughts to the Governor.

Even after the Governor acts to accept, decline or defer the recommendations, the process doesn't end. For some recommended actions, the next step will be an interim task force focusing on a specific measure and including a more targeted group of stakeholders along with state staff.

Finally, some actions will require legislative action. Some of this may come in the 2005 session, but more complex and far-reaching questions may not be ripe for legislative treatment until 2007. This is to ensure that sufficient analytic work has been performed to gauge costs and benefits and their distribution. It also will ensure that interested parties will participate as the measure is designed and evaluated.

The Advisory Group appreciates that major actions with significant and widely distributed consequences will require deliberation, not a rush to judgment. Given the imperatives of climate change effects, the Advisory Group does not suggest indefinite delay, but strongly favors a deliberate, yet urgent process with access for all affected parties.

2.4 An "Investment-Based" Solutions Strategy

Many, perhaps most, of the actions considered by the Advisory Group look and act more like an investment portfolio than unrecoverable costs. That is, they require that the State and its citizens *invest* financial — and political — capital in energy efficiency and new technologies. The net effect will be both reduced emissions of greenhouse gases such as CO_2 and positive long-term financial and quality of life returns to the State and to Oregonians.

To collect these benefits, Oregonians will have to be disciplined investors with a long-term investment horizon. Year by year state and private business investment dollars must be put into improving the emissions efficiency of Oregon's economy. While some of these investments may not pay off for years, or in a few cases, even decades, many will recover their costs and pay dividends within only a year or two. Some may involve actions that would not have been taken except to contain the effects of global warming. Short-term needs and satisfactions may have to be deferred.

Advisory Group members understand there will be competing demands for these investment dollars and political tradeoffs to be made. Political processes often yield to near-term consumption over investment, whether expressed in popular government benefit programs or demands for tax cuts. It will be necessary to distinguish and perhaps separate these capital investments from the costs of day-to-day government and business operations.

Two examples from our own Pacific Northwest history are pertinent to choices facing us today and illustrate this effect.

1) **The Columbia River Hydropower System:** In the 1930s, investment began in what has become one of the largest hydroelectric power plants in the world with the energizing of Bonneville and Grand Coulee dams on the Columbia River. The projects were very costly at the time. Concerns were expressed that they would be financial "white elephants," producing far more electricity than the region could absorb or pay for. Roosevelt's New Deal Administration went ahead with them anyway, justifying them on other public policy grounds: they would put people to work during the Depression; they would make the central Washington desert bloom with agricultural products; and they would ease

navigation and river commerce inland past the Cascades of the Columbia, the fearful rapids now covered by the waters behind Bonneville Dam.

In the ensuing seventy years, the long-term financial benefits have paid back the initial investment many times over, as some of the lowest power rates in the nation have supported the region's economic development. Today about 40 percent of Oregon's electric power comes from this system at low and relatively stable rates that modulate swings in fossil fuel commodity costs. While we are still struggling to reconcile hydroelectricity with sustainable salmon and steelhead populations, the hydroelectric system gets us over 40 percent of the way to climate neutrality in our electric power system.[5]

Several of the Advisory Group's key recommendations involve developing a second generation of renewable resources: new wind, solar and biomass plants added to the existing hydroelectric base to meet our energy supply needs while producing no greenhouse gases.[6]

2) **Energy Efficiency Investments Under the Northwest Power Act of 1980:** The second example is more contemporary. In 1980 the region decided that, as new electric generating capacity was needed, we would invest first in energy conservation – in reducing demand for power – if that was less costly than building new power plants. We would do so, principally, by investing in more energy-efficient light bulbs and refrigerators and in set-back thermostats that lowered the heat when you weren't home, then automatically raised it when you returned from work. We invested in more efficient commercial lighting and industrial motors. Overall the utilities in the Pacific Northwest invested some $2.3 billion between 1991 and 2002, resulting in savings of some 1,818 average megawatts (aMW) annually. That's equivalent to three large coal plants' worth of electricity we have not had to generate. It came at a fraction of the cost of nuclear generation, gas, coal, or any other source, and at near-zero environmental cost. The average real levelized cost of these savings was approximately $12 per MWh. This is about one-third the market price of electricity during this period.

That entire $2.3 billion investment is fully recovered in electricity bill savings about once every 24 months.[7] The Advisory Group proposes to rely heavily on Oregon's ability to replicate this investment and these returns again in the next 20 years, realizing 960 aMW in Oregon and a regionwide total of 3,000 aMW, at comparable investment levels and savings.

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5 The hydropower system is, however, threatened by global warming, which is projected to reduce Cascade Mountain snowpack by 50% or more by 2050 (University of Washington: "Effects of Climate Change on Water Resources in the Pacific Northwest." July 3, 2001). The snowpack serves as an extra "reservoir" for storing water to be used throughout the year. Potential increases in spring runoff would have to be spilled, rather than used to generate power.

6 Recent studies have evaluated the cost-effectiveness of a "Renewable Portfolio Standard" that would require at least 20% of a utility's supply come from renewable resources. In 2001 the U.S. Energy Information Administration (USEA), using generally conservative assumptions – stable fossil fuel costs, higher renewable costs – found virtually no cost difference between the first case (no RPS) and the second (20% RPS). Two other studies, by USDOE's Interlaboratory Working Group and the Union of Concerned Scientists, using cost assumptions closer to market conditions that have prevailed since 2001, both found the 20% RPS case produced lower consumer costs as well as conferring co-benefits such as more jobs and reduced local air pollution. For Oregon, the UCS study projected ±1500 more jobs and $620 million in consumer cost savings by 2020.

7 Per personal communication Tom Eckman, Conservation Resources Manager, Northwest Power and Conservation Council, September 16, 2004. This assumes an average value of the savings (i.e., the costs utilities avoided from reduced purchases from the short-term wholesale power market) of $37/MWh (= 3.7¢/kWh). In 2001, when West Coast market prices for electricity spiked to $250/MWh and higher, the savings realized in the Pacific Northwest were commensurately greater.

These investments to create lower energy costs for Oregon and Northwest businesses have also created new jobs insulating houses, installing thermostats, and designing and building energy-efficient windows and manufactured housing. Along the way Oregon companies developed markets in other states for those same windows and manufactured housing units, bringing new dollars and jobs back into Oregon.

Today, if Oregonians had the option of driving more fuel-efficient cars that still met their needs and the option of driving them fewer miles to work or shopping, they would realize a similar return on investment when gasoline prices rise as they did in 2004.[8] Citizens would be better insulated against the disruptions that such price spikes cause in Oregon's economy, and the dollars saved could circulate within Oregon, creating more state jobs and goods.

This time the "public purposes" are different from those of other eras: not creating jobs in a Depression or saving energy in an oil embargo, but reducing emissions of CO_2, methane and other greenhouse gases. They also include creating energy price stability and building economic opportunity for the next generation of Oregon workers and entrepreneurs.

The tools should look very familiar, however. They are tools for investing in energy efficiency — in homes and businesses, in the means of transportation, and in land use and transportation systems design for our urban areas. They are also investments in a new generation of renewable energy technologies — not in large hydroelectric dams this time, but in smaller, run-of-the-river projects, wind turbines, solar photovoltaic cells, and crops from Oregon farms that can be converted to biodiesel fuels.

Some energy efficiency investments can be earning positive returns in two years or less. Some renewable energy technologies, such as large wind, are competitive today with fossil fuels, so those early returns will be positive also. Other investments will take longer to turn positive, as the dams did, but they will immediately result in more stable energy costs for Oregonians, again, as the dams did.

In the larger process, Oregonians will discover products and services to be marketed to other areas that are slower in responding to global warming threats as described in Section 2.5 below.

There will be other less intuitively obvious benefits. Lower emissions from power plants and vehicles will mean cleaner air in Medford, Bend, Portland and other communities. Not only will there be more clear days for admiring Mt. McLoughlin, the Sisters and Mt. Hood, but there will be healthier people to enjoy the view and fewer kids handicapped by asthma and other respiratory diseases.

Energy market competition from conservation and renewables can have the effect of lowering demand for fossil fuels and, therefore, damping energy prices from those and competing sources.[9] A future energy user who is relying on a mix of conservation, renewables and gas will be

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[8] Even before 2004's price increases at the gas pumps, from 1999 to 2003 Oregon monthly household energy budgets were squeezed by average increased costs of 12% in electricity, 17% in natural gas, and 50% in gasoline (data compiled by The Oregonian from USEIA and other sources, September 11, 2004).

[9] See, for example, U.S. Energy Information Administration Study SR/OIAF/2001-03, June 2001.

contributing to environmental values, *and* saving on energy not used due to efficiency gains, *and* paying a lower rate for each delivered kilowatt hour (or therm of gas).

Where it seems the fairest and most efficient way to accomplish our goals – especially in capturing energy efficiencies in buildings and equipment – we rely on regulatory tools such as building codes. We appreciate that regulation can be politically difficult to propose and sustain. We note, however, that over 40 percent of the 3,000 MW the region now is conserving is coming from building codes and appliance efficiency standards. These are the *lowest cost savings* being captured day in and day out. Households save money directly on their energy bills and in lower costs for the goods they buy. Oregon businesses save on operating costs and produce more cost-competitive products and services. Designed properly and applied consistently, regulatory tools can contribute to a competitive "level playing field" among businesses. Each could make comparable investments to conserve energy, so that no one competitor can offer lower costs in the short term by deferring these investments and the benefits they confer on the community as a whole.

2.5 The Economics of Addressing Global Warming: Costs, Investments and Opportunities

2.5.1 Overview

In any discussion of the economics of addressing global warming, it's easy to get trapped in the underbrush of near-term costs and to miss the forest of rational economic calculation of long-term savings. In some cases, those near-term costs are going to be higher, but often the costs will be matched and more by the returns Oregon families and businesses will see directly. The savings that are captured as *avoided costs* of adaptation to a warmer, wetter and more uncertain world may be more substantial still.[10]

Near-term costs are further offset by helping Oregon businesses stay *competitive* in a world moving to greenhouse gas limits. Costs of recommended actions should also be measured against the *economic opportunities* that will open for Oregon businesses that develop goods and services for sale to a world in the market for low greenhouse gas solutions.

Most activities we engage in as Oregon citizens and businesses – driving a car, turning on a light, disposing of garbage – result in emissions of greenhouse gases. Any serious proposal to reduce these emissions affects us all, and we need to understand its costs and benefits. This is challenging for a set of actions that looks ahead fifty years. Much is unknowable: what fuel prices will do; what statutory constraints may be adopted; and what technology breakthroughs can mitigate costs. Once firm decisions have been made on actions, we can use computer models to predict costs and benefits (with the qualification that uncertainty increases the farther ahead we look).

[10] The effects of global warming on Oregonians and the costs we will bear in adapting to climate change are not just a function of what we do in one state. They also depend on the degree to which our leadership and actions are matched by leadership and actions across the country and around the globe.

It also may be useful for us to think about "cost" in more than one way. For example, there is the "cost" of an investment we might make, whether in the stock market or in buying a more efficient refrigerator. We pay an up front "cost," but we recover that cost and begin to earn net "benefits" (e.g., savings on energy costs) if it is a good investment. Many actions proposed here accomplish both lower emissions *and* efficiencies that are cost-effective. That is, they will return to consumers a net return independent of their value in reducing greenhouse gas emissions.

Other actions involve developing products and services that can be marketed outside of Oregon, as well as applied at home. As greenhouse gases are increasingly regulated by states, the federal government and, through international agreements, Oregon can gain an economic advantage by selling mitigation actions we have developed to reduce Oregon's emissions.

We incur a "cost" when we buy health or fire insurance. We don't know if we'll be sick or have our house burn down, but we believe paying these "costs" is justified to mitigate our risk against those outcomes. We still shop for the lowest-cost insurance that will do the job, but we understand it's a good decision even though it may not provide a return under all scenarios. We're advised not to underinsure, so there's enough coverage to rebuild our house or our health.

When we pay for building dams and levees to protect against devastating floods, we're incurring a similar "cost" for a different kind of insurance, one that diverts the potential for catastrophic danger and damage. There is a difference: we speculate that our house *might* burn down, but we know floods *will* occur. We know that occasionally – every fifty to one hundred years – a truly catastrophic flood will occur (for example, in 1996, 1948 and 1894). We pay an upfront cost and get our return in the form of less destruction and lower costs to rebuild. We think it is money well spent.

The actions in this package are insurance that is similar in different respects to both examples. We are insuring against the potentially calamitous consequences of overheating the planet. We can only approximate their specific effects, geographic distribution and intensities; but science tells us that they are at least as likely as that hundred-year flood. We can choose to pay an up front "cost" to mitigate against the worst of these effects by reducing our use of fossil fuels and the emissions that are released. We want the lowest cost actions in our "policy," certainly. We also want them to add up to an effective response.

The question for Oregonians is: Do we think these measures are a good value for our dollars?

2.5.2 Costs of Measures

The Advisory Group is recommending to the Governor a package of 46 actions across seven areas of State, business and citizen activity. In most cases, staff has developed a preliminary estimate of whether an individual measure is projected to be *cost-effective to the consumer over the effective lifetime of the measure.*[11] More than 60 percent of the proposed measures meet this

[11] The summary tables at the front of each category of measures (e.g., Energy Efficiency) show, in two columns to the right, the estimated savings in greenhouse gas emissions and a preliminary staff estimate of whether the measure is cost-effective.

first test (or are policy choices without direct cost implications). Other measures may also prove to be cost-effective for their insurance value or when weighed against the costs of adaptation.

Some measures – developing renewable energy technologies or increasing forestation of under-producing lands – in many applications can be expected to yield commercial profits and jobs to offset implementation costs.

Of the most significant (Category I) actions, two are constrained by law to be cost-effective. The Northwest Power and Conservation Council's 20-year energy efficiency goals (incorporated in action EE-1) must meet a test, established in federal law, of being cost-effective to the region (and in nearly all cases, to individual electricity consumers). The California state law establishing the "Pavley" auto tailpipe pollution standards (TRAN-1) requires that new cars be able to meet the twin tests of low greenhouse gas emissions and cost-effectiveness to the purchaser.[12] For these and other recommended measures, the Advisory Group has adhered to this "investment" standard of cost-effectiveness to the buyer over the life of the measure or vehicle. Note also, that if the energy-efficient appliance or auto purchase is financed, the added capital costs would be offset by the consumer's month-to-month savings.

The other Category I action with the greatest potential for cost consequences is the proposed greenhouse gas allowance for electricity, gas and oil (GEN-2). Estimating the costs and benefits of this measure depends on its design, on future energy markets and costs, on technology evolution and on future regulatory actions. We have little control over most of this, but we can model different paths to our greenhouse gas content goal and select one that offers the greatest greenhouse gas savings at the lowest cost and risk. For example, a least-cost path may be one that allows utilities and other suppliers time to phase out old equipment and ramp in new renewable and other technologies. An effective design may maximize the ability to trade emissions savings and offsets with California and Washington, lowering compliance costs. By relying on energy efficiency and renewable technologies that are unaffected by fossil fuel markets and price swings, compliance actions can minimize abrupt rate shocks to consumers and cost impacts that could undermine the competitiveness of Oregon businesses. The design of a greenhouse gas allowance mechanism can be made sensitive to competitive pressures on Oregon businesses if other states and countries are not pursuing parallel paths to greenhouse gas reductions.

It is also true that many of the actions that could be required to meet a greenhouse gas content allowance will be cost-effective, beginning with the energy efficiency actions recommended above (EE-1). Many of the wind, hydroelectric and biomass projects that could be used to comply with the standard are cost-effective today and are being installed. We can also expect technologies that are still higher-cost today, such as solar photovoltaics, to drop in price as production economies of scale are achieved and technological gains are made.[13] Well-crafted public policies such as Renewable Portfolio Standards can accelerate this effect by creating market demand that encourages technological advances and cost gains. The nation and the Northwest have

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[12] California, AB1493, Pavley, 2002.

[13] When modern wind turbines were first being designed and installed in 1980, they offered about the same unsubsidized output cost ($0.25/kWh) that unsubsidized photovoltaic solar generation offers today, supporting expectations that similar output cost reductions can be anticipated. See also Footnote 6 for renewable energy cost projections from different informed analysts.

experience with this effect through development of auto, appliance and housing energy efficiency standards that resulted in miles-per-gallon gains, more efficient refrigerators and thermally-efficient windows.

Because the cost and other consequences of a greenhouse gas content allowance are not knowable until a design has been developed and modeled against a range of future scenarios, the Advisory Group recommends that an interim task force do the designing and modeling over the next 12 to 18 months. Prior to the submission of any proposal to the 2007 legislature, all interested parties will have a reasonable idea of how the allowance mechanism would work and what the cost and other outcomes should be.

All far-reaching measures such as these three will need to be revisited regularly by State officials and legislators. Circumstances will change, new choices will emerge, market costs of energy will move up or down, and adjustments will be needed to maintain a least-cost path.

2.5.3 Avoided Costs

No one likes paying more up front for an appliance, a car or a house. But as noted above, we've been doing just that in Oregon and the Pacific Northwest for the last 20 years as we've bought more efficient appliances, cars and houses, installed insulation and better windows, or introduced more efficient equipment in our stores and factories. They've paid back the extra cost, on average, in about eighteen months from the date of purchase.

Avoided costs from efficiency gains are just the beginning. Slower growth in demand for power and gas means less new transmission infrastructure – poles and pipelines – has to be built, saving more cash. Competition from new efficiency measures and renewable technologies will act to hold down costs from competing fossil fuels.

Efficiency gains are exactly like having a share of your power coming in at a fixed price (renewables also possess this price stability attribute). So households, and especially businesses, avoid the uncertainty for a crucial cost input into their budgets and cost-of-goods. Any energy-dependent company can tell you about the cost of electricity price uncertainty when unprecedented price spikes hit the West Coast as they did in 2001.

Then there are the avoided costs of coping with the physical changes global warming is already bringing: heavier rains, longer dry spells and more extreme storms. We think of those as "future" costs that we can discount (maybe they won't arrive?). But we're already starting to pay them in the form of higher insurance premiums today, as insurers try to anticipate their liabilities for *future* loss claims. Companies that are susceptible to higher costs of doing business in a warmer world are paying higher insurance premiums if they fail to address this business risk. Flood insurance costs are rising in low-lying coastal and other storm-prone areas.

There's one other aspect of avoiding costs that gets too often overlooked. It's the value to Oregon of keeping dollars at home, circulating in our local economy, supporting new businesses (preferably ones that can export products and import more dollars). When we spend our limited capital on imported energy from the Middle East or Venezuela, on coal from Wyoming, on gas from Alberta, and soon from overseas as liquid natural gas (LNG), it's gone. Every dollar exported to buy non-local energy is like a little loss of muscle fiber from our collective economic body. We have to compete in a muscular world economy, and we're a little weaker each time we fill the gas tank.

2.5.4 Staying Competitive

Our major trading partners in Europe, Canada and Japan are already investing in new goods and services to deal with global warming. We cannot stay competitive by standing still. If you're a multinational doing business in the European Union or Japan (think Intel, Hewlett-Packard, Boeing, or Nike), you're already working out your greenhouse gas reduction and trading strategies. This is particularly true now that the Kyoto Protocol on greenhouse gas reductions became effective following Russia's signature. All of Oregon's major trading partners in Europe and Asia, plus Canada, will be doing business with consideration for the greenhouse gas emissions consequences of their actions. If trading with the United States results in a greenhouse gas penalty, these countries may adjust the volume or value of their transactions. Conversely, if Oregon's products and services come at a lower greenhouse gas cost, we could gain a trading advantage over states that are slower off the mark.

Oregon businesses will need to adjust to a Kyoto-constrained world or risk their overseas markets going to companies, states and countries that anticipated the greenhouse gas rules taking shape globally. As Canadian Ambassador Michael Kergin warned in speaking to a Portland business breakfast on December 8, 2004, "American businesses risk being shut out of many commercial opportunities in Kyoto-compliant markets."[14] Kergin applauded the self-starting qualities of U.S. businesses that adapt their products and practices to the expectations of their customers, an attribute he said they must leverage to compete in a Kyoto-constrained world.

[14] Quote from notes taken during Ambassador Kergin's presentation.

The Kyoto Protocol

The Kyoto Protocol to the United Nations Climate Change Convention will become legally binding on its 130 Parties on February 16, 2005. The Protocol's entry into force means that from that date:

1) Thirty industrialized countries will be legally bound to meet quantitative targets for reducing or limiting their greenhouse gas emissions.
2) The international carbon trading market will become a legal and practical reality. The United States will not be able to participate in that market unless it elects to ratify the Protocol.
3) The Clean Development Mechanism (CDM) will move from an early implementation phase to full operations. The CDM will encourage investments in developing-country projects that limit emissions while promoting sustainable development.
4) The Protocol's Adaptation Fund, established in 2001, will start preparing to assist developing countries to cope with the negative effects of climate change.

Under the Kyoto Protocol, industrialized countries are to reduce their combined emissions of six major greenhouse gases during the five-year period 2008-2012 to below 1990 levels. The European Union, for example, is to cut its combined emissions by 8 percent, while Japan will reduce emissions by 6 percent. The total cut in greenhouse gas emissions is at least 5 percent from 1990 levels in the commitment period 2008-2012.

Only four industrialized countries have not yet ratified the Kyoto Protocol: Australia, Liechtenstein, Monaco and the United States. Together Australia and the United States account for over one third of the greenhouse gases emitted by the industrialized world. The 30 industrialized countries that have committed to individual, legally-binding targets to limit or reduce their greenhouse gas emissions represent 62 percent of the greenhouse gas emissions emitted by the industrialized world, which is 32 percent of total global emissions.

2.5.5 Exploiting the New Markets

Business Week, in its August 16, 2004, cover story on global warming, argues that "Companies that pioneer low-emissions cars . . . or find cheap ways to slash emissions will take over from those who can't move as fast." What are some of those opportunities for Oregon businesses and entrepreneurs?

(A) Services

The Pacific Northwest pioneered energy conservation in the 1970s and '80s. The Northwest Power Act of 1980 directed us to buy the cheapest "electricity" first, even (especially) if it came from efficiency savings. In the process, we developed expertise that we've marketed elsewhere in the U.S. Portland Energy Conservation, Inc. (PECI) started life as a City of Portland office, spun itself off as a private enterprise, and pioneered commercial building "commissioning" to verify that the new building controls and other efficiency technologies would deliver savings as advertised. It now sells these services nationwide.

In Oregon and Washington, members of the International Brotherhood of Electrical Workers (IBEW) and National Electrical Contractors of America (NECA) are developing skills in photovoltaic equipment installation, sometimes by providing their services free to install solar panels at schools. Lane Community College in Eugene now trains renewable energy technicians.

Large wind energy projects in Eastern Oregon are generating power at competitive and stable costs, paying royalties to farming families double-cropping their lands with windmills, and raising rural tax bases. They're also creating marketable skills at engineering firms like CH2MHill and law firms like Stoel Rives, both of whom now sell their project development services outside Oregon.

Another play for eastern Oregonians is likely to be *bio-sequestration* services – a fifty dollar word for growing more trees and plants that can retrieve carbon from the atmosphere and hold it for long periods of time. They could also make money from animal manure from which methane can be retrieved and converted to electricity. Other sources include biomass crops, which can be burned for energy with zero net CO_2 emissions, and changing fertilizing and tilling practices to approaches that reduce emissions or allow soil uptake of carbon. As carbon limits are imposed around the globe on utilities and other companies, agricultural practices that can offset carbon emissions will have growing market value.

Portland has an international reputation in urban design circles for being a city that takes planning and quality of urban life seriously. A co-benefit, which is becoming a marketable service, is that a city planned for efficiency is a city that can manage its greenhouse gas emissions. Portland and Multnomah County are working toward a goal of reducing greenhouse gas emissions to 10 percent below 1990 levels by 2010. Urban design firms like David Evans and Associates can leverage their contributions to Portland into competitive advantages elsewhere. Oregon architecture and engineering firms are learning to design "green" buildings that can earn national certification points and lead to contracts inside Oregon and out.

The Climate Trust, an Oregon-based private non-profit organization, has created a service niche that uses CO_2 offset dollars from new power plants and other sources to fund renewable energy, energy conservation, transportation savings, bio-sequestration and other projects that reduce greenhouse gas emissions.

As an example of how we can gain even when Detroit is slow to react, Portland stands to benefit as the market for hybrid (gasoline plus electricity) cars grows in the U.S., fueled by new greenhouse gas-reduction regulations being adopted by California (and recommended in this Oregon Strategy). The major companies supplying these cars today are Toyota, Honda and Ford. The Port of Portland is the primary West Coast port of entry for Toyota and Honda. More manufacturers and suppliers are needed.

(B) Goods

Oregon builders of windows and manufactured housing, to take two examples, were pushed to build their products to the higher efficiency standards set under the Norhtwest Power Act of 1980. Both industries found outside markets for those same products as other areas responded to higher energy costs in the 1990s.

Their counterpart today may be Shell Solar in Vancouver, Washington, which manufactures photovoltaic panels. Soon Shell could be using the silicon-producing capability of firms like Wacker Siltronics in North Portland or other wafer manufacturers from the high-tech community.

As markets generally value "green" products more highly, there can be spinoff benefits for Oregon Country Beef, wild (and sustainably-harvested) salmon, and the emerging Oregon organic natural foods cluster. It's no coincidence that Kettle Chips, with a state tax credit, assistance from Oregon Department of Energy and funding help from the Energy Trust of Oregon – innovative responses – installed the largest grid-connected solar energy facility in the region on its factory rooftop in Salem this year.

Oregon firms like PPM Energy develop wind farms all over the country. A new product, Green Tags, was pioneered by the Bonneville Environmental Foundation in Portland. BEF sells Green Tags that are wind-based (supplied by PPM, BPA), solar-based (from developer Gerding-Edlen's Brewery Blocks and other solar installations), and even cow manure-based (from the Port of Tillamook's waste-to-energy project) in 30 states and up into Canada.

As the market for efficient products and processes heats up, the high-tech and software industries on the West Coast all stand to profit if they anticipate where more precise and responsive instruments and controls will deliver efficient energy results. Opportunities range from home heating systems to interstate high-voltage transmission lines.

(C) Investment Opportunities

The Pacific Northwest was once the international leader in renewable energy technology and applications. That was when we were investing in and developing the hydropower capability of the region's rivers and snowpack.

Renewable energy could again be a key economic development "cluster." In addition to devising new efficiencies for the existing hydropower and transmission infrastructure, Oregon has wind, biomass and waste conversion opportunities awaiting smart exploitation.

Oregon isn't positioned to sell anyone gas or coal conversion technology, but we could be leaders and net gainers if we move earlier than the competition to develop the renewable and co-generation technologies and siting services that can then be offered for sale. What's needed? First, a regional market that's big enough and active enough to stimulate entrepreneurial activity and attract investment capital. Oregon by itself probably isn't big enough. But this is no time to be parochial. The states of the Pacific Northwest, plus British Columbia, are a respectable market with a good number of companies already developing products for the renewable energy market. If we want them to stay here, creating jobs and wealth, we have to offer them an accessible West Coast market. We'll have to work California into the strategy as well.[15]

Fortunately, our Governor has joined with these neighboring jurisdictions to establish a framework – the West Coast Governors' Global Warming Initiative – with the shared goal of reducing greenhouse gas emissions West Coast-wide. Developing renewable generating technologies and infrastructure, including transmission capacity, is on the common agenda.

Oregon, Washington and California will all need to do their part, starting with public commitments to purchase output, setting expectations for greater utility reliance on renewables to meet load growth and replacement needs, and addressing regional infrastructure needs (e.g., transmission and integration services, expedited siting and permits). The states will need to consider how regulatory and tax codes may be adapted to encourage local industry development.

Oregon's educational system needs to be supported and, in turn, needs to provide industry support by building basic and applied skills in energy efficiency and renewable technologies. Our universities already support resource evaluation (Oregon State University has wind resource expertise and the University of Oregon has solar expertise). Technology research, development and demonstration are relatively weaker here. One idea is establishing a regional "incubator" for technologies that are past laboratory work, but not yet ready for commercial prime time, something Oregon and Washington could elect to collaborate on.

2.6 Partners

So, Oregon makes its contributions and investments. What difference can we make? We're not even one of the largest states in this country, and global warming is a global concern. If we make these investments today, what's to keep competitors in other states from tilting the playing field to take short-term advantage of Oregon businesses while they invest for long-term sustainability?

[15] California has demonstrated the importance of local market stimulation when it became the world leader in installed windfarm capability in the 1980s. Today it has a 20% Renewable Portfolio Standard requirement for its electric utilities, tax credits for citizens and businesses to install their own equipment and is considering committing an additional $100 million in state funding to further buy down the costs of solar installations and to build solar manufacturing capability in the state.

These are all good questions that the Governor must be prepared to answer, and the Advisory Group offers its help in doing so.

First, we're not alone. The agreement reached among the three governors of Oregon, Washington and California means the West Coast states will proceed in parallel and sometimes joint efforts. If our three states were a single nation, we'd be the seventh largest emitter of CO_2 from fossil fuels globally, so we are a player. Our emissions are significant, and our efforts to reduce them can and must be comparably substantial. The actions being proposed in that process, which parallel our own, include joint procurement efforts for hybrid and low-emissions vehicles for state fleets, providing electric hookups at truck stops along the Interstate-5 corridor, and other actions where lower costs and greater benefits can be obtained through three-state coordination.

While many recommendations that the Advisory Group is making to the Governor are consistent with the West Coast Governors' Global Warming Initiative, the Advisory Group also explicitly adopted the seven key recommendations from the "West Coast Governors' Global Warming Initiative, Staff Recommendations to the Governors," November 2004 (Appendix E):

1. Set new targets for improvement in performance in average annual state fleet greenhouse gas emissions.
2. Collaborate on the purchase of hybrid vehicles.
3. Establish a plan for the deployment of electrification technologies at truck stops in each state on the I-5 corridor, on the outskirts of major urban areas and on other major interstate routes.
4. Set goals and implement strategies and incentives to increase retail energy sales from renewable resources by one percent or more annually in each state through 2015.
5. Adopt energy efficiency standards for eight to 14 products not regulated by the federal government, establishing a cost-effective efficiency threshold for all products sold on the West Coast.
6. Incorporate aggressive energy efficiency measures into updates of state building energy codes, with a goal of achieving at least 15 percent cumulative savings by 2015 in each state.
7. Organize a West Coast Governors' conference in 2005 to inform policy-makers and the public of climate change research concerning the West Coast states.

Second, we have other partners in the six New England states and five eastern Canadian Provinces that form the Conference of New England Governors and Eastern Canadian Premiers, who have committed to a regional "Climate Change Action Plan." Other states — New York, New Jersey, Delaware, Maryland — are stepping up to their responsibilities. The state-based initiatives have one other important quality: they are bipartisan. Both Republican and Democratic governors are leading their states into this effort.

Third, our major trading partners in Europe and around the Pacific Rim are Oregon's partners as well. The nations of the European Union are considering ways that would allow individual U.S. states to participate directly with European countries in greenhouse gas credit trading programs if the states adopt comparable limits on emissions.

In fact, we should be less concerned about acting prematurely and far more concerned with being into the marketplace too late. Already other countries have established leads in important commercial areas: Denmark in wind turbines, Japan in solar cells, and Canada in fuel cells. We believe Oregon and the West Coast can compete in greenhouse gas technology markets, but not if we lag behind in our commitments at home (see Section 2.5 above, The Economics of Addressing Global Warming: Costs, Investments and Opportunities).

SECTION 3

Context

3.1 A Primer on Global Warming

The Earth is kept habitable by gases in the atmosphere that capture part of the sun's energy. Those gases are called "greenhouse gases" because of their heat trapping properties. At a relatively stable concentration, these gases are beneficial. However, human activity has produced a significant increase in greenhouse gases in the atmosphere since the beginning of the Industrial Revolution in the mid-18th century. At this point, additional greenhouse gases are pollutants that are destabilizing the earth's climate with potentially catastrophic consequences.

Climate and Weather

We all confuse the two words in everyday speech, usually with no dire effect. But for purposes of dealing with climate change, the distinctions are crucial.

Weather is changeable day by day. Cool, wet Augusts are not unknown, nor are 70 degree days in February. Local, transient phenomena produce local, transient weather effects. Can the planet truly be warming if we're having a damp and dreary summer?

Yes, because climate is "weather" averaged over time. Western Oregon's climate typically consists of cool, wet winters that build snowpack in the mountains, showery springs that last through the Rose Festival in June, and dry, warm to occasionally hot summers that end about mid-October. Eastern Oregon is colder in winter and hotter in summer, while the coast is the reverse due to climate effects of the ocean and mountains.

There are larger temporal climate effects too. Most of us recognize that an El Nino disturbance will result in drier than normal weather over the year, while a La Nina will be wetter than usual. More expansively, there is a switch (known as the Pacific Decadal Oscillation) that seems to flip over every 20 to 30 years, going from a drier-than-usual climate to a wetter-than-usual one.

None of these tells us if it's going to rain this weekend. That's weather.

Global warming is a climate effect, a rise in average temperatures, a background effect with which shorter-term climate effects interact to produce weather. A hot year will tend to be hotter and a cool year not as cool. A La Nina might produce more intense rain in April and less moisture in August than it would have absent the effects of climate change. Global warming will have – is likely already having – such weather effects. Some of these are predictable: overall warmer weather year round, less snowpack, melting glaciers, more extreme storms and so on. Some are far harder to predict. Will it rain more or less? On the same time table as now or will the pattern shift?

We can't use today's weather to judge in what ways climate change is already affecting us. We can look at global average effects and effects observed over the passage of years to see where the disturbing patterns of climate change are coming into focus.

There are growing numbers of dramatic signs that this is occurring. Every writer on the subject has a favored illustration. The snows atop Mount Kilimanjaro that inspired Hemingway's famous story will be gone within fifteen years after enduring for thousands. Robins are seen 250 miles north of the Arctic Circle, where native Inuits have no word in their language for "robin." Alaska permafrost is melting, buckling highways built atop it, while the Iditarod sled race must start two weeks earlier to be certain of snow on the trail to Nome. Glaciers are retreating around the world. The Arctic ice cap is 20 percent smaller than it was 25 years ago, and scientists predict open seas at the North Pole within 50 years.

Closer to home, University of Washington scientists project a 50 percent reduction in Northwest snowpack by the middle of this century. The glaciers in Montana's Glacier National Park are retreating at an accelerated rate, and the forest fire season is arriving earlier and staying longer.

The *Third Assessment Report*, published by the United Nations Intergovernmental Panel on Climate Change (IPCC) in 2001, concluded that human-generated emissions have contributed substantially to the observed global warming over the last 50 years (see Figure 7 below). Since 1990, the globe has seen the 10 warmest years on record. Since 1980, we've seen 19 of the 20 warmest. The Earth is warming faster than any time in the past 1,000 years.

Global warming, or global climate change caused by greenhouse gas pollution, is arguably the single most serious threat to human civilization and even to the most robust and insulated ecosystems. Sources of greenhouse gas pollution from human activity have changed the global climate and will continue to change the climate for the foreseeable future. Our challenge is to slow, then reverse these global changes, so their near-term effects can be contained and the longer-term life-threatening impacts do not occur.

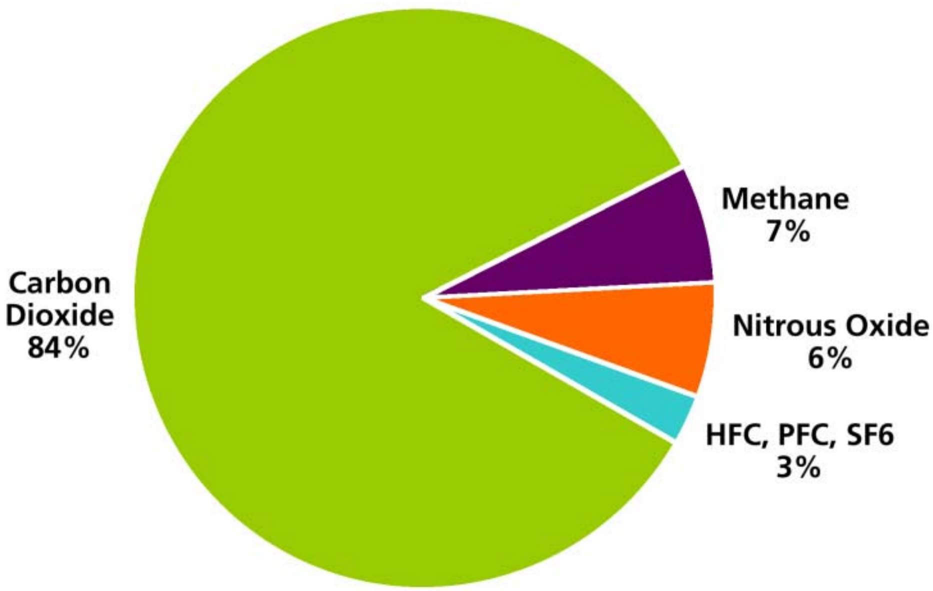
The United Nations Framework Convention on Climate Change (UNFCCC), ratified by the United States in 1992, set an objective to meet the challenge:

> The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [human-induced] interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. *(UNFCCC, Article 2*)

Many IPCC scientists believe that stabilizing the atmospheric concentration of carbon dioxide at 500 to 550 parts per million (ppm), which would represent a doubling since 1750, would help avoid the most dangerous changes. However, that is a best estimate and assumes that sudden, unanticipated shifts in climate conditions do not occur. In any case, we are on a track to reach this level of atmospheric CO_2 by around 2050 and to continue onward to a tripling or quadrupling of pre-industrial CO_2 concentrations in a "business as usual" scenario. At these higher levels, we face dangerous, potentially calamitous effects on our economy and our physical environment.

Methane, nitrous oxide and halocarbons are significant greenhouse gases, but the pollutant of greatest concern is CO_2. Figure 4 below illustrates that about 84 percent of greenhouse gas pollution in Oregon comes from CO_2 emissions. The majority comes from burning fossil fuels, such as coal, gasoline, diesel and natural gas. Emissions from methane, primarily from cattle and landfills, contribute 7 percent to the state's greenhouse gas pollution; nitrous oxide emissions, primarily from agricultural practices, contribute about 6 percent. Manufactured halocarbons, which include hydrofluorocarbons, perfluorocarbons and suflur hexafluoride, account for the remaining 3 percent.

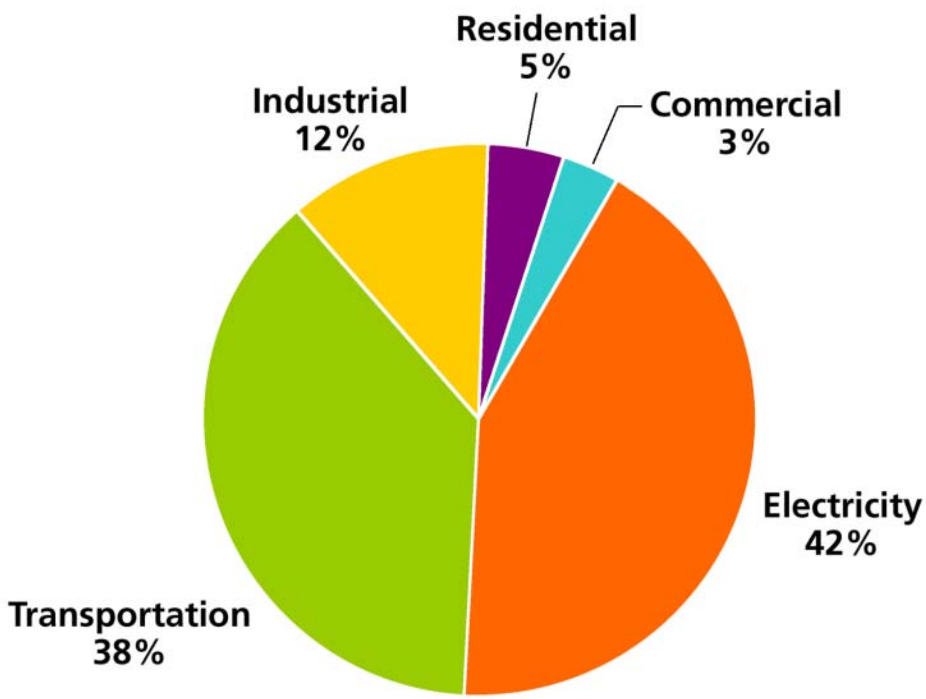
Figure 4
Oregon Greenhouse Gas Emissions Sources in 2000



Source: Oregon Department of Energy (see Appendix B)

Figure 5 shows the percentage of CO_2 emissions from each major sector in 2000. CO_2 is the predominant greenhouse gas emitted by Oregon. The largest source of CO_2 emissions is from the production of electricity that Oregonians use including electricity generated out-of-state for Oregon consumers. Transportation emissions, mostly from cars and trucks, account for a close second. Fossil fuels used directly in the industrial, residential and commercial sectors are mostly from burning natural gas and distillate fuel.

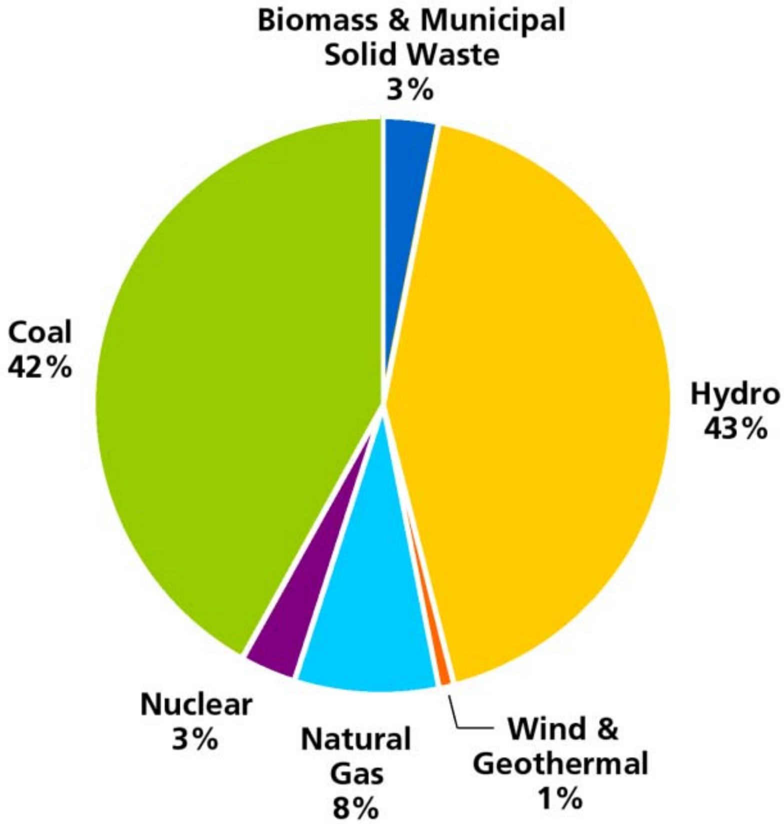
Figure 5
Oregon's CO_2 Emissions from Fossil Fuels by Sector



Source: Oregon Department of Energy (see Appendix B)

Figure 6 looks in greater detail at the types of electricity generation that supplied Oregon's consumers in 2002. The generation mix in Figure 6 is based on power plants whose output is dedicated to Oregon utilities. Utilities can generate this output at facilities that they own, either in-state or out-of-state. It also includes cases where a utility purchases the output of a specific power plant. For Portland General Electric (PGE), the total of such purchases and ownership is less than its total electric load. In that case, the calculations for the figure assume that the remainder of the electricity is supplied to PGE by a mix of resources from the Northwest Power Pool. Utility purchases from the Bonneville Power Administration (BPA) under long term contracts are credited with the BPA resource mix.

Figure 6
Electricity Generation Mix Supplying Oregon 2002



Source: Oregon Department of Energy (see Appendix B)

In addition to these greenhouse gases, changing patterns of land use and land cover are altering the atmospheric concentrations, especially from changes to tropical forests. Everywhere, soils, forests and other vegetation have the potential to remove CO_2 from the atmosphere. They also contribute emissions of CO_2, methane and nitrous oxide as forests are cut and as agricultural practices disturb soils and add chemicals.

Emissions of sulfate aerosols, microscopic airborne particles released from burning fossil fuels, introduce a further complexity. These aerosols tend to reflect sunlight before it reaches the Earth and, therefore, have a cooling effect on the atmosphere. On the other hand, carbon black, or soot, is also released from burning fossil fuels, and it can have a localized warming effect that is only just beginning to be understood.

Scientific Uncertainty

Critics of efforts to contain global warming often argue that the science is "uncertain." Of course all science is "uncertain" in that it is subject to challenge by new evidence or interpretation. The "scientific method" requires that challenges to an assertion or hypothesis must be based on data and analysis that are peer-reviewed and critically examined by other scholars with expertise in the same field to see if it stands up to scientific scrutiny.

We rely on the "greenhouse effect," a phenomenon not seriously disputed in any academic institutions, to maintain the habitability of the earth. This effect is the result of a layer of gases in the upper atmosphere that surrounds the earth. This necessary layer traps, as heat, some of the solar energy that enters the atmosphere, maintaining a temperature range within certain optimal limits that sustains life on the planet as we know it. Without this effect, scientists estimate that temperatures would be over 50 degrees F. cooler, too cold to be habitable. Conversely, too thick a "blanket" of these greenhouse gases can overheat the surface of the earth and affect habitability.

Skeptics of global warming sometimes imply that "uncertainty" is the same as a 50/50 possibility that global warming is either occurring or not. Even if this were true, a 50% chance that the world would see some of the likely impacts scientists are forecasting would merit a determined response. But the inference is both misleading and untrue.

An overwhelming majority of the world's climate scientists are finding a causal link between growing concentrations of CO_2 and other greenhouse gases generated from human activity (fossil fuel and other sources) and a warming of the planet – beyond levels known to prevail in pre-industrial times. These scientists serve on the Intergovernmental Panel on Climate Change (IPCC), assembled by the United Nations from leading academic institutions around the globe.

Considerable uncertainty remains over the timing, distribution and potential severity of climate change on storm activity, sea level rise, forest health, water supplies, tropical disease propagation and other terrestrial effects. These effects could as easily be more severe, or occur more rapidly and abruptly, as less severe and slower to gather. As computer models become more refined, we can expect to understand in greater detail the timing and distribution of effects. What is clear, however, is that the more greenhouse gas concentrations accumulate, the more we will be affected by these changes.

Climate science asks that we apply probabilities to complex, long-term effects and adopt policies in response that must span decades. For example, Climate Change 2001: The Synthesis Report by the IPCC gives 66 percent to 90 percent confidence in data that show that there were higher maximum temperatures and more hot days over land areas in the latter half of the 20th century, but it has 90 percent to 99 percent confidence that the globe will see such changes during the 21st century. It also has 90 percent to 99 percent confidence that there were and will be higher minimum temperatures, fewer cold days, fewer frost days, and a reduced range of temperature changes from day to night over land areas. We must learn to work with such probabilities, acknowledge both the evidence and the remaining uncertainty, and focus on solutions.

When global climate change models incorporate the effects of increased concentrations of greenhouse gas pollution, aerosols and cyclic changes in the sun's output, the models most closely recreate the past climate history and give us most confidence in future estimates. While all three components play a role in our climate, greenhouse gases are now the major determinant.

Figure 7

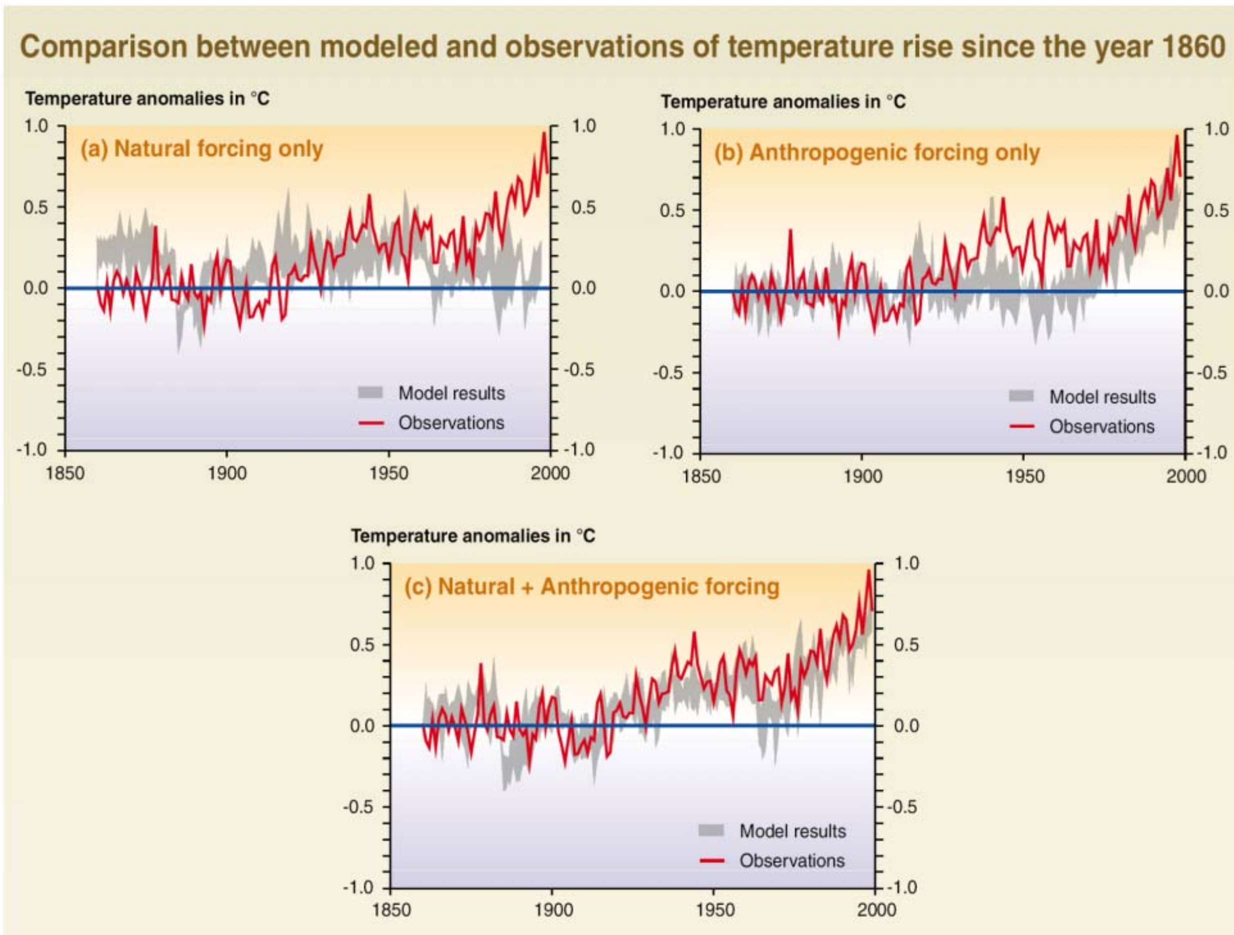


Figure SPM-2: Simulating the Earth's temperature variations (°C) and comparing the results to the measured changes can provide insight to the underlying causes of the major changes. A climate model can be used to simulate the temperature changes that occur from both natural and anthropogenic causes. The simulations represented in the band in (a) were done with only natural forcings: solar variation and volcanic activity. Those encompassed by the band in (b) were done with anthropogenic forcings: greenhouse gases and an estimate of sulfate aerosols. And those encompassed by the band in (c) were done with both natural and anthropogenic forcings included. From (b), it can be seen that the inclusion of anthropogenic forcings provides a plausible explanation for a substantial part of the observed temperature changes over the past century, but the best match with observations is obtained in (c) when both natural and anthropogenic factors are included. These results show that the forcings included are sufficient to explain the observed changes, but do not exclude the possibility that other forcings may also have contributed.

Figure 7 above demonstrates the relationship between natural and anthropogenic (human-generated) sources of climate variation. Credible forecasts require modeling both sources of variation. In the period after 1960, most of the modeled variation is man-made, rather than natural. The combined model (c) using both sources of variation closely tracks observed climate changes.
Source: The Third Assessment Report of the Intergovernmental Panel on Climate Change, "Climate Change 2001: The Synthesis Report, Summary for Policymakers," p.7.

Complexity and Modeling Climate Change

The physical systems that shape our climate are staggeringly complex. Computer models can begin to simulate this complexity and predict the future, but in broad rather than detailed terms. Current models of climate cause and effect are now delivering useful results at the global level. More localized effects – such as storm activity in the Pacific Northwest – are cautionary, but still imprecise. This is because local climate is affected not just by global shifts in temperature regimes, but by the interactions of those changes with local topography, ocean currents and heat exchanges.

Depending on how global heat exchangers (ocean currents and winds) are altered, the Northwest might see more weather systems coming in from the Pacific (therefore, wetter weather) or from Alaska and Canada (more storms bringing less moisture). More dramatic changes in the globe's engines of heat exchange could bring weather patterns that are largely unpredictable locally, except that as more heat is moved about the earth, there likely will be more intense storms and other weather events.

Since 1958, an observatory on Mauna Loa, Hawaii has measured atmospheric CO_2 concentrations. Based on data from polar ice cores, the pre-industrial concentration was about 275 parts per million (ppm). In March 2004, the atmospheric concentration reached 380 ppm. Until recently, the annual growth in the CO_2 level was less than 2 ppm. For the last two years it has been about 3 ppm. Because the immediate increase in the rate is not understood, it is not possible to know how long concentrations will continue to increase at this higher rate.

About half of annual human CO_2 emissions (which include the burning of tropical forests) are absorbed by terrestrial plants and oceans. This absorption is also referred to as a "carbon sink," or bio-sequestration, as mentioned earlier. It includes physical and biological processes in the upper layer of the oceans. It also includes re-growth of trees in the eastern U.S. and Europe and expanding Siberian forests from changes in precipitation and temperature. It appears, however, that sinks are not taking up CO_2 as fast as they were. In any case, uptake is not increasing to compensate for increased emissions. Science is finding the potential for serious adverse consequences to ocean life from CO_2-induced changes in water chemistry.

The IPCC projects that CO_2 concentrations will rise to between 450 and 550 ppm by 2050 and will continue to increase until the international community agrees to change worldwide emissions. The increase in CO_2 emissions since 1750 has not been exceeded during the past 420,000 years and likely not during the past 20 million years.

Greenhouse gases affect global warming on long time scales, both because of their lifetime and the long time it takes the atmosphere to reach equilibrium with the warming effect of the gases. Many greenhouse gases remain in the atmosphere from many decades to centuries. Achieving a stabilized concentration level requires significantly reducing emissions over a long period. Even on a path to significant reductions, carbon dioxide concentrations and temperature continue to rise for centuries after emissions peak and begin to be reduced. Temperatures will also continue to rise even after the concentration has stabilized at a new level, such as double CO_2 concentrations at 550 parts per million. Even under the reduction scenarios depicted, we should expect impacts at a scale that will require adaptation as well as mitigation actions.

Given the path we are on, the IPCC projects that global average temperatures will rise from between 1.4˚Celsius to 5.8˚C (2.5˚Fahrenheit to 10.4˚F) by 2100. While there is uncertainty about the specific consequences of global warming in the Northwest, scenarios from various global climate change models show the types of changes we could expect to see within the next few decades. *The Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest* (see Appendix C) states, with intermediate certainty, that the average annual temperature in the region will increase by 2.7˚F by 2030 and by 5.4˚F by 2050, with consequences outlined below.

3.2 The Costs and Consequences to Oregon of a "Business as Usual" Strategy

Dr. Thomas Karl of the National Atmospheric and Oceanic Administration and Dr. Kevin Trenberth of the National Center for Atmospheric Research published a paper in the December 5, 2003 issue of *Science* warning that, on our current course, "the likely result is more frequent heat waves, droughts, extreme precipitation events and related impacts [such as] wildfires, heat stress, vegetation changes and sea-level rise." A 2001 report from the National Research Council says greenhouse warming and other human alterations of the climate system may increase the possibility of large, abrupt and unwelcome regional or global climatic events. Researchers do not know enough about such events to predict them accurately, so surprises are inevitable.

In the Northwest, scientists at Oregon State University, the University of Washington and other study centers have already observed measurable warming. The Institute for Natural Resources at OSU hosted an all-day symposium in June 2004, "Impacts of Climate Change on the Pacific Northwest," to solicit guidance from the region's own cadre of qualified climate and resource scientists. The objectives included pooling what is now known about state-level and regional effects and identifying critical gaps in our knowledge. The symposium resulted in the *Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest.*

The Climate Impacts Group of the Joint Institute for the Study of the Atmosphere and Ocean at UW reports that, over the last century, the regional average temperature increased by 0.8˚C (1.5˚F). Precipitation has increased both east and west of the Cascades. East of the Cascades, the increases are dominated by changes from April to July. West of the Cascades, the largest increases are in November, which has overtaken December as the wettest month. While precipitation has increased, there has been a decline in snow water equivalent in the spring. Likewise, the timing of the peak snowmelt has advanced 10 to 40 days earlier in most of the Western United States over the last 50 years, according to Dr. Edward Miles of the Climate Impacts Group. Likely specific impacts are summarized in the next sections.

3.2.1 Water. Warmer temperatures will lead to less snow pack on the mountains in the winter, which would mean less water available later in the summer. A study by the Climate Impact Group indicates the April 1 snowpack in the Cascades declined about 50 percent from 1950 to 2000. The largest losses are at the lower elevations, consistent with increased warming. Scenarios of future climate change show a further decline by 2090 that could reach 72 percent below the base period of 1960 to 1990. This could reduce summertime stream flows by 20 to 50 percent, according to an article in Science (February 20, 2004, p. 1124). Peak flows will occur four to six weeks earlier than present. This will increase the risks of both winter and spring floods and summer droughts. In particular, rainfall-dominated rivers in the low-lying basins west of the Cascades would likely see increased flooding from more rain-on-snow events.

Earlier melting is expected to change the timing of water in the rivers, which will affect fish and wildlife and commerce on the river. Lower summer flows would reduce water for irrigation, especially in Eastern Oregon where irrigation districts rely on melting snow to sustain rivers through the summer and to refill reservoirs. Lower summer flows would also increase the impacts of water pollution or require more restrictions on discharges into rivers.

In addition to increased winter runoff, streams and rivers are likely to be affected by more intense storms. Both will increase the peak surge in rivers, which increases erosion and flooding. Increased storm intensity would affect smaller and urban drainages more than larger streams and rivers. Increased erosion can reduce available farmland, create hazards and difficulties in navigable waterways, and harm fish and wildlife.

Warmer water temperatures will harm native species such as salmon and could interfere with the life cycle of all fish, as could a change in the timing of runoff and precipitation going into rivers. For example, the Climate Impacts Group reports that the migrating smolt stage is when salmon are most vulnerable to climate variations. The timing of arrival in the coastal waters plays a big role in their survival, and changes in water flow from climate variability can change that timing. Climate factors also influence the type, distribution and abundance of predators, as well as the salmon's food supply in estuaries and the ocean.

Changes in the timing and volume of stream flow in the snow-melt dominated rivers could have economic impacts on the hydropower system. If climate change decreases the summer flow at the same time rising temperatures increase demand, both locally and in California, then the price of summer power could rise substantially. On the other hand, the price of winter power could drop as warmer temperatures decrease demand for heating while more precipitation as rain increases the supply of hydropower.

The Climate Impacts Group projects that precipitation will increase above that of the 1990s by about 7 percent by 2050, but it has less confidence in that projection, which is based on the combined results of eight climate change models. There will likely be larger year-to-year variation in precipitation.

On the other hand, some models suggest that as Arctic ice cover diminishes, storms will tend to track further north at key times of the year and the Pacific Northwest could see reductions of precipitation of up to 40 percent. Some 20 percent of the ice cap over the North Pole has melted since 1979, according to Dr. Kelly Falkner at Oregon State University. If the current rate of loss of the Arctic ice cover continues, the summertime cover could disappear by 2050.

There is little or no room for growth in supply in the regional reservoir storage system. According to Dr. Miles, the regional system was designed on the assumption that about 70 percent of the regional storage would be snow pack. Consequently, we have the ability to store behind dams only about 30 percent of the annual average flow. It would be hard to increase that storage. The level of water scarcity is relatively new. Demands on water systems are growing, but supplies remain essentially fixed. There is less margin of safety available to cope with the unexpected.

3.2.2 Human Health. Scientists expect a higher increase in human mortality due to higher temperatures, even though there may be a decrease in cold-related illnesses and mortality. Abnormally high temperatures in Europe claimed more than 20,000 lives in August 2003. Another potential threat is from changes in regional diseases when vectors, such as insects that live or thrive in warmer climates, migrate northward.

3.2.3 Agricultural Production. Changes in temperature, precipitation, water availability and soil moisture will affect the distribution and productivity of crops. They will also increase the prevalence of diseases and pests. Although Northwest agriculture will probably be able to adapt to any changes with the first doubling of CO_2, adaptation will likely be costly. Dr. Eban Goodstein and Laura Matson of Lewis and Clark College suggest, in an initial estimate, that the lost value of irrigation water could range from $465 million to $2.4 billion. They caution that the estimate should be considered illustrative, not predictive.

3.2.4 Oceans and Coasts. The IPCC's most recent mid-range estimate is for an average rise in sea level of 9 to 88 cm (4 inches to 35 inches) by 2100. Recent studies of Greenland glaciers indicate greater instability than previously expected. This indicates that average global sea level rise may be close to one meter this century, the high end of the IPCC predictions.

This sea level rise could cause severe disruption for ecosystems and people along the coast. Likely effects include increased coastal erosion, both from sea level rise and increased wave height. The Climate Impacts Group notes that the increased frequency of storm surges may be more significant for low-lying areas than sea level rise alone.[16] Likewise, increased storms could lead to saturated ground and more slope failure in coastal bluffs and hills. Impacts would vary along the Oregon coast because of the variation between rocky shores and sandy beaches and because the southern part of the coast is rising due to

[16] Scientists and engineers in the United Kingdom have estimated that by 2080, "hundred-year" floods could be occurring every three years, potentially affecting 3.5 million people in low-lying areas and inflicting costs in the tens of billions of pounds annually. Large numbers of properties would become uninsurable. (David King, Chief of the Office of Science and Technology, United Kingdom, quoted in Science Magazine, January, 2004, p 176).

geological forces. To the south, that coastal rise is offsetting initial sea level rise. However, relative sea level is rising between Florence and Astoria.

According to Dr. Roger Samuelson at Oregon State University, global climate change is likely to change the local coastal ocean circulation and ecosystem and regional meteorological conditions. There would be both direct and indirect effects from global warming on regional winds in terms of mean wind direction and, hence, waves; in addition, warmer temperatures would result from the enhanced greenhouse effect. Winds, stratification of water levels and currents are extremely important for coastal habitat.

Concurrently, climate change will produce a different fish community in the ocean waters off the Northwest coast. This fish community may not support large salmon populations or other commercial species, according to Dr. Robert Emmet at the National Oceanic and Atmospheric Administration Northwest Fisheries Science Center. Dr. Goodstein and Ms. Matson estimate that economic damage from salmon population decline due to global warming will range from $359 million to $7.2 billion by 2050. Given other influences on salmon productivity, the Climate Impacts Group notes that future changes in salmon population and distribution are speculative; it is clear, however, that a warmer climate and lower summer stream flows can be expected to further affect the stocks adversely.

3.2.5 Forests. Forests are expected to experience stress as well. Tree growth is likely to be limited by drier summers, and the possible increase in wildfires, pests and disease are significant threats. At higher elevations there will be loss of alpine habitat.

In the near term, increased levels of CO_2 may act as a fertilizer. Along with possibly increased precipitation and slightly warmer temperatures, tree growth may increase. However, as forests become denser under favorable initial circumstances, they will demand more water and, therefore, will become even more vulnerable to stresses from increasingly dryer, warmer summers and from climate variability.

The Climate Impacts Group points out that increases in summer temperatures without increases in precipitation would result in greater potential evapo-transpiration and decreased soil moisture. That would result in increased stress and decreased productivity, which would overwhelm any benefit from increased CO_2 fertilization of trees.

Warmer temperatures will also favor pests and disease. As the climate continues to change and become more severe, the forests will become even more susceptible to variable climate. Larger and more intense forest fires are a likely result.

Dr. Ron Neilson, U.S. Department of Agriculture Forest Service, reports that there have been high fluctuations in wet-dry climate cycles for the last 30 years in the Northwest. Climate change may increase the annual and decadal variability of precipitation. He concludes that climate variability, far more than fire suppression, has led to the sudden rise and severity of wildfires in recent years. In fact climate variability is the primary determinant of fire occurrence, location and timing. Fuel buildup from previous fire suppression exacerbates fire intensity, but not its occurrence, according to Neilson.

3.3 Mitigation and Adaptation

The Advisory Group distinguishes between "mitigation" of greenhouse gas emissions (actions that will reduce emissions and their warming effects) and "adaptation" to global warming (those actions necessary to cope with the warming effects that are already unavoidable). Nearly all the actions included in this Strategy are mitigation actions intended to arrest and reverse the growth of such emissions, eventually reducing them to levels compatible with historically stable global climate patterns. Mitigation is generally afforded highest priority by scientists, given the potentially calamitous consequences to the planet of unrestrained warming.

However, Oregonians and their counterparts in other states and countries will also face adaptation questions, even if the mitigation actions are all adopted and implemented vigorously. This is because the accumulation of CO_2 and other greenhouse gases in the atmosphere has grown significantly from levels generally associated with sustainable climate patterns; and, as discussed above, global temperatures are already rising and will continue do so for the next several decades, even with deliberate and effective mitigation.

Since it is unrealistic to propose that modern industrial societies will be able or willing to end fossil fuel consumption abruptly and live with the ensuing social and economic disruptions, most scenarios assume continued emissions and accumulation of greenhouse gases well into this century. Under the most optimistic assumptions, accumulations level off at between 450 parts per million (ppm) and 550 ppm by mid-century before effective mitigation – if it is vigorously and effectively pursued – begins to reduce concentrations. If this is the case, then Oregonians and others will be adapting to the effects of warming for several generations to come.

These effects on Oregonians, discussed elsewhere, may include: more frequent and more intense floods, forest fires and sea level rises that could threaten low-lying coastal communities. Additional effects will likely include altered habitats and changes in wildlife species distribution; more constrained water supplies (affecting hydroelectricity generation); warmer, wetter winters; hotter, drier summers; and heightened exposure to diseases now largely confined to the tropics. All of these effects and more will require adaptation.

If only Oregon and a few other jurisdictions act to mitigate emissions, the adaptation challenge grows commensurately and, eventually, beyond our capacity to adapt. The Advisory Group's mitigation strategy assumes that Oregon does not act to mitigate alone, but as one of a growing alliance of states and nations rising to this challenge.

The Advisory Group believes the next task, once Oregon has determined its near-term mitigation course, will be to identify adaptation actions, set an adaptation strategy and implement it. This task is beyond the charter of this Group, but final recommendations include encouraging the Governor to assemble a successor group of citizens and government agencies to take on this next great challenge.

Part Two

SECTION 1

Introduction to Recommended Actions

The Advisory Group's list of recommended actions fall under seven major areas:

- **Integrating Actions (IA)**
- **Energy Efficiency (EE)**
- **Electric Generation and Supply (GEN)**
- **Transportation (TRAN)**
- **Biological Sequestration (BIOSEQ)**
- **Materials Use, Recovery and Waste Disposal (MW)**
- **State Government Operations (GOV)**

Actions are also grouped as Category I or Category II as follows:

Category I: Significant Actions for Immediate State Action. These actions promise significant greenhouse gas savings (usually greater than or equal to 0.25 million metric tons/year of CO_2 or equivalent savings); are technically feasible today; and are often the most cost-effective first actions to be taken.

Category II: Other Immediate Actions. These actions make sense for Oregon to undertake immediately. In most cases the greenhouse gas savings are less significant, but costs are also proportionately lower and many actions are cost-effective now.

Each specific action is identified with an abbreviation denoting the action area and a number for reference (e.g., IA-1). Category I and State Government Operations actions are listed below. A full discussion of Category I and II recommended actions under the seven major areas follows.

Table 1
Category I and State Government Operations

Integrating Actions

IA-1	Recommend the Governor adopt near-term, intermediate and long-term greenhouse gas emissions goals for Oregon.
IA-2	Urge the Governor to renew the charter of the Advisory Group on Global Warming (or a successor body) to continue the Advisory Group's unfinished agenda.
IA-3	The Oregon University System should develop strategic and targeted research, development and demonstration (RD&D) programs for greenhouse gas reduction technologies.
IA-4	The Advisory Group should work with state agencies, colleges and universities, schools, non-profit organizations and businesses to develop a global warming education program that will provide information and outreach to the public.

Energy Efficiency

EE-1	Meet the Northwest Power and Conservation Council goal of implementing cost-effective electricity efficiency measures for electric users and an equivalent goal for natural gas users.

Electric Generation and Supply

GEN-1	Increase the renewable content of electricity.
GEN-2	Recommend the Governor create a special interim task force to examine the feasibility of, and develop a design for, a load-based greenhouse gas allowance standard.
GEN-3	Support Oregon PUC's review of rules and tariffs for renewable and combined heat and power facilities.

Transportation

TRAN-1	Convene an interim task force to recommend a proposal for the Environmental Quality Commission or the Governor and the Legislature to adopt emission standards for vehicles.
TRAN-2	Integrate land use and transportation decisions with greenhouse gas consequences.
TRAN-3	Promote biofuel use and production.

Biological Sequestration

BIOSEQ-1	Reduce wildfire risk by creating a market for woody biomass from forests.
BIOSEQ-2	Consider GHG effects in farm and forest land use decisions.
BIOSEQ-3	Increase forestation of under-producing lands.

Materials Use, Recovery and Waste Disposal

MW-1	Achieve the waste generation and recycling goals in statute.
MW-2	DEQ should develop guidance to clarify alternative final cover performance at larger landfills: Demonstrate control of gas emissions comparable to geomembrane cover.
MW-3	Provide incentives for larger landfills to collect and burn a minimum percentage (65 percent to 80 percent) of methane generated.

State Government Operations

GOV-1	State agencies should use their agency Sustainability Plans as the tool for agencies' dynamic involvement in greenhouse gas reductions with respect to both their internal operations, and their external program or regulatory activities.
GOV-2	Through a collaborative effort, the Departments of Energy, Environmental Quality and Administrative Services should develop a process to educate agency personnel about opportunities for GHG reductions including how to set goals and calculate GHG reductions.

Criteria for Reviewing and Assigning Actions to Categories

The Advisory Group is a diverse group of Oregon citizens who brought equally diverse life experiences and perspectives to their task. Applying their perspectives was a valuable first step in evaluating the choices Oregon faces, but the Group used a more systematic evaluation tool. The Group agreed on the following criteria, although each Group member may weigh and prioritize these independently.

1. Are significant quantities of CO_2 or other greenhouse gases reduced, avoided or sequestered?
2. Are the reductions captured early or delayed?
3. Is the measure technically feasible? How do its costs compare to the costs of alternative actions (or inaction)?

4. Does the measure require new legislation or regulatory action? By whom? Are there political barriers to be addressed?
5. What collateral benefits or costs may accompany the measure? These might include uneven distribution of impacts, economic development gains, education values, demonstration values, and overlap with the West Coast Governors' Global Warming Initiative.

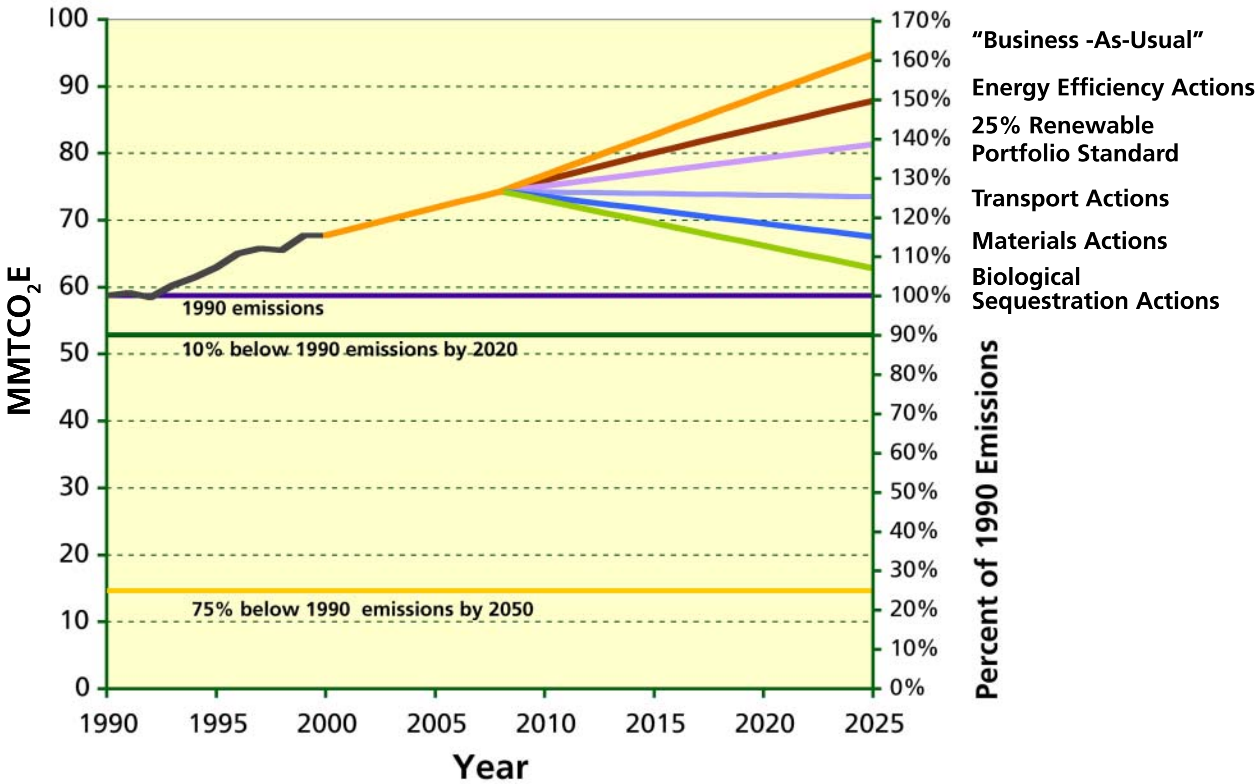
Estimated Reductions from Implementing Actions

Figure 8 below integrates several aspects of historical and forecast emissions of greenhouse gases for Oregon, the mitigation actions and their relationship to the recommended goals. Emissions are expressed as million metric tons of carbon dioxide-equivalent (MMT CO_2E) in the left vertical axis from 1990 through 2025. It shows how far we can expect to reduce greenhouse gas emissions by implementing all the recommended actions in Part Two.

1. As in Figure 3 in Part One above, the horizontal lines show the level of greenhouse gas emissions (a) in 1990, (b) at 10 percent less than 1990 levels, and (c) at 75 percent below 1990 levels. These levels represent proposed goals for the State's strategy and provide a context for the expected reductions from the proposed actions. The 75 percent reduction of greenhouse gas emissions is what is required globally to stabilize atmospheric concentration of greenhouse gases at 550 parts per million of carbon dioxide equivalent, or double the pre-industrial concentration. Although double the pre-industrial concentration, this level is assumed to avoid serious climate impacts.
2. As in Figure 1 in Part One above, the black line that rises from 1990 to 2000 represents historical greenhouse gas emissions from Oregon. The orange line that continues beyond that represents a forecast of future emissions under a "business as usual" approach, which assumes we continue present activities (including many that now restrain greenhouse gas emissions), but take no additional special actions to reduce these emissions. The vertical axis on the right shows differences from 1990 levels, with 1990 representing 100 percent of emissions.
3. The graph then shows the cumulative, sequential reductions that would result from the proposed actions as subtractions from the "business as usual" approach. The reductions begin in 2008, based on the assumption that it would take that long for most of the new proposals to begin to be effective. The "actions" are the sum of the emissions reductions from each of the major types of recommended actions. Each "action" creates a new, lower forecast of emissions. For example, all of the reductions from energy efficiency actions are subtracted from "business as usual," then all of the reductions from adopting a 25 percent renewable portfolio standard are subtracted from the level achieved by the energy efficiency actions, and so forth. The reductions also account for the interactive nature of specific actions, as described in the discussion of the actions. Therefore, the total of all actions for a sector and between sectors is not necessarily the sum of all the individual actions within every sector.

   Also, the reduction labeled "25% Renewable Portfolio Standard" (RPS) should be seen as a placeholder for the carbon allowance standard proposal. In fact, the State could set a carbon allowance standard at any amount of reduction. If the recommendation for a carbon allowance standard is adopted, it would be up to the task force designing the carbon allowance standard to recommend a specific level of reduction and the means – possibly including an RPS – to achieve that level.

FIGURE 8
Historic and Forecast Greenhouse Gas Emissions in Oregon and Estimated Cumulative Reductions from All Measures in Sequence



In sum, Figure 8 shows that if we continue "business as usual," by 2025 Oregon's greenhouse gas emissions would be 61 percent higher than 1990 levels. On the other hand, if we accomplish reductions from all the actions recommended in the report, our emissions would only be 7 percent higher than they were in 1990 and trending downward, consistent with the Advisory Group's recommended 2020 goal.

SECTION 2

Recommended Actions

Integrating Actions to Reduce Greenhouse Gases

Issue:

The four recommended Integrating Actions described in this section are crosscutting and affect the six other action areas. In order to slow and then reverse greenhouse gas (GHG) emissions, it is essential to have a long-term focus.

Solutions:

Action IA-1 recommends goals that provide a long-term context for all other actions. The goals extend out 45 years.

IA-2 recommends that the Governor continue the work this group has begun. This includes appointing a successor group that could oversee implementation of global warming actions, develop adaptation actions and develop additional actions to reduce GHGs.

IA-3 recommends the Oregon University System develop a research strategy for technologies and techniques to reduce GHGs and adapt to climate change. This would allow Oregon to foster new industries and would help Oregon's economy.

IA-4 recommends that the subsequent Advisory Group develop an education and information plan and implement it with stakeholders throughout the state.

Table 1 (IA)

Category I – Significant Actions for Immediate State Action

IA-1	Recommend the Governor adopt near-term, intermediate and long-term greenhouse gas emissions goals for Oregon.
IA-2	Urge the Governor to renew the charter of the Advisory Group on Global Warming (or a successor body) to continue the Advisory Group's unfinished agenda.
IA-3	The Oregon University System should develop strategic and targeted research, development and demonstration (RD&D) programs for greenhouse gas reduction technologies.
IA-4	The subsequent Advisory Group should work with state agencies, colleges and universities, schools, non-profit organizations and businesses to develop a global warming education program that will provide information and outreach to the public.

IA-1: Recommend the Governor adopt near-term, intermediate and long-term greenhouse gas emissions goals for Oregon.

Near-term Goal: The Advisory Group recommends the State meet its existing Benchmark #76, which specifies that carbon dioxide (CO_2) emissions should not exceed 1990 levels. Recognizing that Oregon is unlikely to meet that benchmark by 2010, the Advisory Group still recommends that Oregon retain this benchmark. As a near-term strategy, we recommend that by 2010 Oregon will arrest the growth of and begin to reduce Oregon's total greenhouse gas emissions, meeting or making measurable progress toward meeting Oregon's current CO_2 benchmark.

Based on current scientific guidance and goals adopted by other states and countries, we consider the following additional goals to be appropriate for Oregon:

Intermediate Goal: By 2020, Oregon's total greenhouse gas emissions will not exceed a level 10 percent below 1990 levels.

Long-term Goal: By 2050, Oregon's total greenhouse gas emissions will achieve a "climate stabilization" level at least 75percent below 1990 levels.

Background: Setting a Goal

Setting a goal and adopting actions that constitute a path to meet this goal send an important signal about the seriousness of Oregon's commitment to reduce greenhouse gas emissions. It encourages the expanded use of renewable energy and increased energy efficiency. It positions Oregon to take significant steps to protect the economic and environmental health of the region.

The appropriate objective of a greenhouse gas (GHG) emissions reduction goal or program is ultimately to prevent dangerous climate change, as stated in the goal of the United Nations Framework Convention on Climate Change. In order to meet such a goal, the first step must be to stabilize emissions and then begin to reduce them.

Most greenhouse gas goals are based on either returning to 1990 emission levels or achieving a reduction in emissions to a level below 1990. Often, there will be an initial goal of reaching 1990 levels, then later achieving the lower emissions target. For example, the Kyoto Protocol to the United Nations Framework Convention on Climate Change uses 1990 as the baseline year for its targets. The Protocol is scheduled to go into effect in February 2005.

Although the Bush Administration has stated it will not submit the Kyoto Protocol for ratification to the U.S. Congress, it is useful to use the same baseline year for goals that the Protocol and other entities have adopted. The first targets of the Protocol differ from what the Advisory Group has recommended for Oregon. If the Congress were to ratify the Protocol, it would have to meet a binding target for the U.S. of achieving a level that is 7 percent below its 1990 greenhouse gas emissions level, on average, over the period from 2008-2012. The Advisory Group is recommending that Oregon work on a longer time frame and aim for greater reductions over a longer time.

Numerous states and cities have adopted goals, either in plans or legislatively. Some address only CO_2; others address all GHGs. Most set 1990 as the base year and then set targets for 2010 and sometimes later for achieving levels below 1990. For example, the City of Portland and Multnomah County have a goal of reducing GHG emissions 10 percent below 1990 levels by 2010. In most cases, the states and cities have developed or are in the process of developing strategies to achieve their goals. Those that set long-term goals often include provisions to revisit the goal on a regular basis and provide for revisions.

Most state goals are expressed in terms of achieving a certain quantity of emissions at a specific year in the future. Current federal policy takes a second approach and sets a target expressed as "*emissions intensity,*" which it measures as the ratio calculated by dividing the greenhouse emissions in a given year by the economic output for that year. A third approach is to set technology-based standards. This approach is tied to specific technologies or sub-sectors, such as Oregon's CO_2 standard for new energy facilities.

Setting absolute quantity limits provides simplicity and certainty. One knows in advance how many tons of GHGs will be emitted into the atmosphere if the goal is achieved. More importantly, *absolute* quantities of atmospheric GHG levels are scientifically meaningful, while *relative* amounts (e.g., relative to transient human factors such as economic activity or growth) are not scientifically meaningful if the object is to control and mitigate global warming. Historically, moderate concentrations of such gases are benign, while the higher concentrations that we are generating pose an extremely serious threat to the ability of the planet to sustain human and other life. The physical processes that take place in the earth's atmosphere, and the threat they pose, are facts that must be faced, whether or not they are convenient to one set of economic strategies or another. Most states and cities have used absolute quantities as goals.

Certainly our mitigation strategies must be sensitive to economic effects if we are to choose the most cost-effective and least disruptive mitigation path; but we must not lose sight of the fact that the ultimate objective is a physical one – benign levels of the gases – not a short-term economic one. Thus, fixed physical emissions goals must be set and achieved independent of changes in population or economic activity.

The current U.S. Administration's goal is to reduce carbon emissions intensity by 18 percent between 2000 and 2012. The Government Accounting Office[17] estimates that this target would represent only a 2 percent absolute reduction from the likely GHG emissions that would otherwise accumulate over the period 2002-2012. Under this scenario, GHG levels in 2012 would remain significantly above 1990 levels. IPCC scientists generally agree that a climate stabilization level of emissions would need to be some 75 percent to 85 percent below 1990 emissions levels.

Technology-based targets (e.g., emissions caps for new power plants) can contribute to reducing physical concentrations of GHGs in the atmosphere, but they are likely to be more effective in the context of established goals to which other actions can also contribute. Oregon, Washington,

[17] United States General Accounting Office, Letter from John B. Stephenson to Senator Ernest F. Hollings and Senator John F. Kerry, regarding "Climate Change Trends in Greenhouse Gas Emissions and Emissions Intensity Factors in the Unites States and Other High-Emitting Nations," October 28, 2003.

New Hampshire and Massachusetts have all set technology-based standards for power plants, either new or existing. California has set technology-based standards for new vehicles. The Northeastern states and some Mid-Atlantic states are considering setting a cap on emissions from power plants.

Consistency with Goals Established by Other States

In 2001, the New England Governors and Eastern Canadian Premiers (NEG/ECP) adopted goals to reduce GHG emissions: (a) to 1990 levels by 2010; (b) to 10 percent below 1990 levels by 2020; and (c) to a long-term goal of 75 to 80 percent below current levels eventually. These goals are consistent with the objectives of the United Nations Framework Conventions on Climate Change. They are ambitious, but they represent the path the region must be on to begin responding to global warming. The Governors and Premiers acknowledged that the science – and the consequences of a failure to respond – compel us to set these goals, even if we don't yet have all the tools and technologies we'll need to meet them. Setting expectations is itself a stimulus to developing needed responses.

The Advisory Group is recommending goals generally consistent with those of the NEG/ECP. In addition to the scientific defensibility of setting such goals, Oregon's action will reinforce the emergence of a common, more predictable level of commitment within the state-led action on global warming.

IA-2: Recommend that the Governor renew the charter of the Advisory Group on Global Warming or appoint a new successor body to continue the Advisory Group's unfinished agenda.

The Advisory Group strongly recommends that the Governor appoint one successor advisory group to deal with the following topics:

- Develop a "Global Warming Adaptation Strategy for Oregon."
- Evaluate and report on implementation progress.
- Reconsider deferred actions.
- Develop an education plan.
- Advise the Governor on influencing and integrating Oregon actions with international, federal and other state-level greenhouse gas reduction policies and activities.
- Appoint two related task forces, one addressing how to limit utility and other stationary GHG emissions, and the second advising the Environmental Quality Commission (or potentially the Governor and the Legislature) on adopting the California tailpipe emission standards for passenger and light-duty vehicles.

To ensure coordination and systematic progress in implementing this Strategy, the Advisory Group recommends that the Governor ask each state agency with implementing responsibilities to designate lead staff. In addition, the Group asks the Governor to appoint a senior member of his staff to oversee implementation and the ongoing work of a future Advisory Group.

The Advisory Group recommends that the Governor continue the work this Advisory Group has begun. The State of Oregon has devoted policy and technical attention to global warming issues directly and indirectly, through energy, waste management, transportation and other policies since 1988. Even if Oregon chose not to be proactive on global warming, we would have to respond to the changing climate and the growing attention paid to this issue globally, nationally and regionally. However, Oregon can continue to do more than react. It can continue to lead by argument and example. In doing so, Oregon will be able to achieve the GHG reductions ultimately required of it at the lowest possible cost. It can capture the co-benefits that its past commitments to carbon constraints, energy efficiency and renewable technologies have already demonstrated are available. It also can position itself to be a market leader in selling goods and services to its slower-to-respond trading partners.

GW Adaptation Strategy: This Advisory Group has left a very large task – adaptation – barely visible on the State's radar screen. And yet we know that if we could arrest the growth in GHGs tomorrow, we face more than a century of climate change and its oceanic and terrestrial consequences. We need to think through strategies for dealing with lower snowpack and altered regional hydrology; forests more susceptible to variable weather, pest infections, stress, and catastrophic fires; and other consequences that are already locked in. The Advisory Group asks that the Governor direct a successor Advisory Group and staff to work with Oregon's academic expertise and with governments and businesses to develop our adaptation strategy for the next 100 years. By then we hope to see a downturn in the atmospheric concentrations of GHGs, the result of beginning today to reduce the emissions that are the subject of this report.

Evaluate and Report on Implementation Progress: The successor Advisory Group should also oversee and report on progress the State, its citizens and businesses have made in implementing the strategy adopted in the current process. Recommending actions is the first and easiest step. Action is more difficult and problematic, the more so in the absence of accountability. The Advisory Group recommends that it or a successor body provide that accountability.

Reconsider Deferred Actions: The Advisory Group began by considering a wide range of options. While it dropped some ideas because they do not seem appropriate at this time, it deferred consideration of many others because they require additional evaluation. This would further quantification of costs and benefits before they are ripe for recommendation to the Governor and Legislature. The successor Advisory Group can work with state staff and interested parties to develop these ideas, as well as other ideas we expect to receive as Oregonians increasingly commit to addressing global warming issues.

Develop an Education and Outreach Plan: The Advisory Group recommends that the subsequent advisory group work with state agencies, colleges, universities, schools, businesses, and non-profit organizations to develop an education and outreach plan:

- to inform Oregonians about the potential impacts to the state, the region, and the globe;
- to inform Oregonians about what they can do to reduce greenhouse gas emissions; and

- to inform Oregonians about what actions may be required to adapt to the changes from global warming that are already unavoidable, and the costs these adaptation actions may impose.

Advise the Governor on international, federal and other state-level greenhouse gas reduction policies and activities: While Oregon acts to reduce its greenhouse gas emissions, it is also participating in regional, national, and international forums. The Advisory Group needs to stay informed and keep the Governor informed of actions that other states are taking, especially on the East and West coasts. It also needs to follow the national dialogue on global warming if there is potential to influence Congressional action. Finally, it needs to be informed of international activities that may affect Oregon's opportunities for finding ways to trade in an international market.

Appoint two related task forces: In addition to a continuation and expansion of the role of the current Advisory Group, the Group separately recommends two additional task forces. One task force would advise the Governor and Legislature on how to limit utility and other stationary GHG emissions. This activity is discussed in GEN-2 and GEN-2a in the Electric Generation and Supply section below. The second task force would advise the Environmental Quality Commission (or potentially the Governor and Legislature) on adopting the California tailpipe emission standards for passenger and light-duty vehicles. This is discussed in the Transportation section under TRAN-1 below.

IA-3: The Oregon University System should develop strategic and targeted research, development and demonstration (RD&D) programs for greenhouse gas reduction technologies.

Oregon universities have expertise related to mitigation and biological sequestration (carbon capture and storage) of GHG emissions. Enhanced efforts to develop and deploy specific technologies, services or applications can enable Oregon to foster new industries. Possible areas of effort include renewable generation technologies; biofuels production; energy efficiency for electricity, natural gas and oil uses; bio-sequestration; materials disposal; and renewable energy production using landfill gas or agricultural or forestry biomass. Large emission reductions are possible.

Oregon's higher education system is capable of designing and identifying applications for beyond off-the-shelf technologies. It is likely Oregon and other states will need such applications in responses to global warming. Oregon has significant competitive advantages. We have a broad array of educational expertise in energy efficiency research, forestry and renewable energy. Oregon has been an early adopter of these technologies and services.

State RD&D funds, combined with funds from competitive grants, could enable Oregon's economy to benefit from local deployment. In addition U.S. and worldwide efforts to reduce GHG emissions will create additional demand for these services. Increased state revenues from increased economic activity could more than offset any state expenditures. Local investment and demonstrations can help develop export markets. Collaboration with other West Coast states could better leverage institutional strengths and develop complementary regional capacity.

Legislative appropriations are required to conduct an inventory of current programs, capability and interests and to plan future development and support for these programs. Not all technologies for GHG reduction merit funding. The Oregon University System, in coordination with GHG work groups in Oregon, Washington and California, should develop strategic and targeted RD&D programs for GHG reduction technologies.

IA-4: The subsequent Advisory Group should work with state agencies, colleges and universities, schools, non-profit organizations and businesses to develop a global warming education program that will provide information and outreach to the public.

Public education is needed to assist Oregonians in making informed decisions and to participate in developing State and individual actions to reduce greenhouse gas emissions that will be practical, effective, and supported by the citizens of Oregon. The Advisory Group would work with stakeholders to develop a plan for public education and outreach on global warming. Topics would include the potential impacts of global warming, what Oregonians can do to reduce greenhouse gas emissions, and how to adapt to changes caused by global warming.

Energy Efficiency Actions to Reduce Greenhouse Gases

Issue: For the past twenty years and more, Oregon has had successful energy savings programs for electricity, natural gas and petroleum users. These have included incentive programs and building codes. Even so, significant savings remain to be captured, and new technologies create opportunities for still more savings. Petroleum and natural gas use emits CO_2 and other greenhouse gases directly. Almost half of the electricity used in Oregon is met by coal and gas-fired generation that emit GHGs.

Solutions: To reduce emissions, Oregonians will need to use all energy more efficiently. Oregon's incentive and building code programs need to be reviewed and upgraded, based on concerns over global warming.

Note that, while the recommended Energy Efficiency actions will require significant effort and investment, the level of effort remains roughly comparable to how Oregon has performed over the last 20 years. In other words, this Oregon Strategy to Reduce Greenhouse Gas Emissions assumes the State will continue its current aggressive level of investment and accomplishment in this area.

Table 1 (EE)

Category I: Significant Actions for Immediate State Action		MMT CO2E 2025	C/E?
EE–1	Meet the Northwest Power and Conservation Council (NWPCC) goal of implementing cost-effective electricity efficiency measures for electric users and an equivalent goal for natural gas users.		
	EE-1a: Expand and coordinate electric incentive programsfor Investor-Owned Utilities (IOUs).	3.20	Y
	EE-1b: Upgrade Oregon building codes to reduce energy use by at least 15 percent by 2015 (building shell measures).	0.52	Y
	EE-1c: Amend building codes to set minimum space and water heating/cooling standards.	0.09	Y
	EE-1d: Adopt state appliance efficiency standards.	0.41	Y
	EE-1e: Advocate with Bonneville Power Administration (BPA) and Oregon electric consumer-owned utilities (COUs) to meet the NWPCC goal.	1.24	Y
	EE-1f: Support Oregon Public Utility Commission (OPUC) actions to evaluate NW Natural/ETO and ODOE natural gas incentive programs.	0.24-0.48	Y
	EE-1g: Advocate with OPUC for Avista and Cascade natural gas utilities to meet energy savings goals comparable to NW Natural.	0.05	Y
	EE-1h: Advocate for federal equipment and appliance efficiency standards.	0.40	Y
	EE 1i: Strengthen state marketing of energy efficiency and incentive programs; initiate Governor's Awards.		Y
	SUB-TOTAL FOR EE-1	6.15-6.39	
Category II: Other Immediate Actions			
EE-2	Support OPUC and COU efforts for modified rate designs to reflect daily and seasonal peak demand.	0.16	Y
EE-3	Support OPUC initiatives for natural gas and fuel switching.	0.10	Y
	TOTAL ALL EE ACTIONS	6.41 -6.65	

Generation mix affects efficiency saving. In the table above, column three shows estimated CO_2 equivalent savings in million metric tons (MMT) through 2025. Column four asks if the action is cost-effective (C/E) - yes (Y) or no (N) - to the consumer over the action's lifetime. (This does not address whether it is cost-effective to Oregon and Oregonians broadly, considering the projected effects of global warming and the costs of adapting to those effects.) The estimates assume displaced generation at a 50-50 mix of gas-fired and coal-fired generation. Refer to Figure 8 in Part Two, Section 1 (Introduction to Recommended Actions) for the cumulative impact of actions.

EE-1: Meet the Northwest Power and Conservation Council (NWPCC) goal of implementing cost-effective electricity efficiency measures for electric users and an equivalent goal for natural gas users.

The Advisory Group recommends achieving Oregon's 960 average Megawatts (aMW) share of the Northwest Power and Conservation Council's regional cost effective energy efficiency for 2005 to 2025 (18 percent of 2002 sales). Meeting this target over 20 years would be the equivalent of saving more than three times the current energy use of a city the size of Eugene. Also recommended are savings of 7.5 trillion Btus (TBtu) of Oregon commercial and residential natural gas between 2005 and 2025 (11 percent of 2003 commercial and residential gas sales).

In March 2004 the NWPCC published its draft conservation resource assessment. The assessment indicates that the NWPCC region (Oregon, Washington, Idaho and the western third of Montana) could reduce electric sales by 2,880 aMW by 2025 if fully effective conservation programs and regulations were implemented. Oregon's share of this savings is 960 aMW. The Council also notes that about 3,000 aMW were saved in the period 1980 through 2002. While many measures have been implemented, technological change has created new opportunities.

Savings of 960 aMW electricity and 7.5 trillion Btus of natural gas are assumed in the energy efficiency case forecast of CO_2 emissions. The efforts needed to accomplish this goal are shown in Table 2 (EE) and Table 3 (EE) below. All of these actions are cost-effective and would improve Oregon's economy. With all these measures, Oregon electric loads would grow 1.0 percent per year from 2002 to 2025. If none of this energy efficiency is captured, loads would grow at 1.6 percent per year and CO_2 emissions would be 5.6 million metric tons (MMT) higher than assumed. The generation displaced by the energy efficiency is assumed to be a 50-50 mix of gas and coal-fired power plants. Acronyms used in the tables below include IOUs (investor-owned utilities) and COUs (consumer-owned utilities), which include people's utility districts, cooperatives and municipal utilities.

TABLE 2 (EE)
Oregon Electric Efficiency Case Energy Savings

MMT CO_2	aMW	Measure	
3.20	545	EE 1a	State and Utility Incentives (IOUs)
1.24	212	EE 1e	State and Utility Incentives (COUs)
0.37	63	EE 1b (electric only)	Improved Building Codes (building shell)
0.32	55	EE 1h (electric only)	Federal Standards
0.09	15	EE 1c	Calif. Equipment Standards*
0.41	69	EE 1d	Calif. Appliances Standards**
5.63	960		Total Electricity

** Oregon can adopt California equipment standards through rule changes.*
*** Adopting appliance standards in Oregon would require legislation.*

Efficiency case natural gas utility incentive savings are for Energy Trust of Oregon (ETO) programs for Northwest Natural and savings from state energy efficiency programs. Estimates of savings from incentive programs and improved building codes are from the Oregon Department of Energy (ODOE).

TABLE 3 (EE)

Oregon Natural Gas Efficiency Case Savings

MMT CO_2	Trillion Btu	Measure	
0.29-0.53	4.6	EE 1f and 1g	Utility and State Gas Incentives
0.15	2.9	EE 1b (gas only)	Improved Building Codes (building shell)
0.08		EE 1h (gas only)	Federal Standards
TBA			Calif. Equipment Standards
TBA			Calif. Appliances Standards
0.52-0.71	7.5		Total Natural Gas

The actions to achieve EE-1a through EE-1i are discussed as individual actions following the discussion of the NWPCC goal below.

Discussion of NWPCC Goal

The most difficult or controversial element of achieving these CO_2 savings is possible legislation to adopt appliance efficiency standards for devices not covered by Oregon building codes (EE-1d). This element is discussed in the West Coast Regional Appliance Efficiency Codes and Standards Working Group Paper (WG4 – from three-state West Coast Governors' Global Warming Initiative).

Allowing builders to take an ODOE Residential Energy Tax Credit would require legislation, but may not be controversial (part of EE-1a). The savings are small, but grow as penetrations grow over time. Integrating efficient water-heating equipment at the time of construction is less expensive and requires fewer incentives than adding equipment later.

Actions by ODOE, ETO, the Oregon Public Utility Commission (OPUC) and the Building Code Division might accomplish the remainder of the savings. These might require budget adjustments for the 2005 session. If a joint OPUC-ODOE assessment indicates the natural gas and electricity efficiency goals cannot be met with existing funding levels, legislation for the electric portion may be needed in the 2007 session because of restrictions enacted in SB 1149[18] in 1999.

The savings goal is achievable. The NWPCC estimates that almost 3,000 aMW were saved in the region between 1980 and 2002. Of this, roughly 40 percent was saved through codes and standards. This is consistent with experience with Oregon programs where 35 percent of savings were from the energy standards in Oregon's building codes. Figure 1 (EE) below shows the distribution of

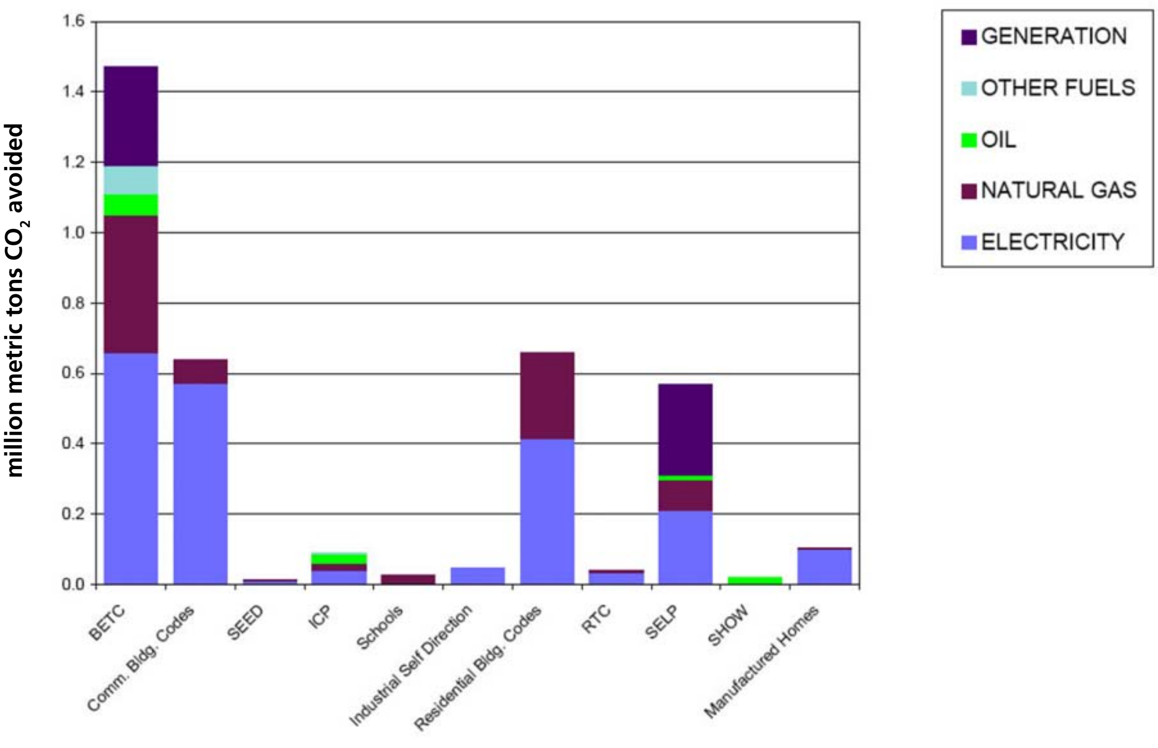
[18] SB 1149 is an electric industry restructuring law of the state's largest investor-owned utilities. Restructuring is designed to give Portland General Electric and PacifiCorp consumers more energy options, while at the same time encouraging the development of a competitive energy market. Current utilities continue to deliver power and maintain the safety and reliability of the poles and wires that deliver power, regardless of who supplies it.

CO_2 savings from state programs. Savings are annual savings from program activity from 1978 through 2002. Savings from program measures reduce CO_2 emission by 3.7 million metric tons per year. Had these savings not occurred, 2002 emissions from Oregon stationary sources would have been 11 percent higher than they were. This indicates that further large CO_2 savings from energy efficiency programs are achievable.

Historical savings in Figure 1 (EE) estimates do not include the additional savings from utility energy efficiency programs during the period. Utility programs added substantial saving, especially in the residential sector. In addition to reducing CO_2 emissions, these and utility program savings reduced costs to businesses, governments and households compared with purchasing fuel or power, and they improved Oregon's economic performance.

Figure 1 (EE)

Avoided CO_2 Emissions in 2002 by Program
(includes all projects from start of program through 2002)
Total avoided emissions = 3,681,000 metric tons CO_2



Key to Figure 1 (EE)

BETC: *ODOE Business Energy Tax Credit*

SEED: *State Energy Efficient Design requirements for new state government buildings*

ICP: *discontinued federal energy efficiency program for schools and hospitals (Institutional [building] Conservation Program)*

Schools: *current K-12 school programs*

Industrial Self-Direction: *measures paid for by large electric users who self-direct their SB 1149 public purpose charges*

RTC: *ODOE Residential Energy Tax Credit*

SELP: *ODOE Small-scale Energy Loan Program*

SHOW: *ODOE State Home Oil Weatherization program*

EE-1a: Expand and coordinate incentives for electric investor-owned utilities (IOUs).

Electricity sales of IOUs accounted for 72 percent of Oregon sales in 2002. The Energy Trust of Oregon (ETO) began running the energy efficiency programs of PacifiCorp and Portland General Electric (PGE) in 2002 and of Northwest Natural gas utility in 2003. Idaho Power runs utility incentive programs in the Ontario area. These IOU programs and those of ODOE and the Department of Housing and Community Development might be better coordinated to be more effective with existing funds. Efforts to this effect are underway.

The most important need is to track total savings to compare to the global warming goals. If increased coordination is not sufficient to meet the goal, increased funding will be needed. Application of the NWPCC's estimates to Oregon indicates that IOU incentive programs could save 545 aMW by 2025. If this conservation goal were not achieved, Oregon's emissions would be 3.20 MMT CO_2 higher (this assumes the extra generation would be a 50-50 mix of new gas- and coal-fired generation). Below are other actions needed to achieve this goal.

Assess Oregon program performance relative to the NWPCC goal in 2006. As part of the study due on January 1, 2007, as required under SB 1149 (1999 session), OPUC, ODOE and ETO should assess the effectiveness of existing electric programs and regulations in 2005 and 2006 to see if Oregon is capturing its share of the NWPCC goal. These assessments should consider state tax credits; loan financing programs and other state incentives; regulatory tools such as building and equipment codes; technology assessments; utility planning assessments; ETO programs; and other SB 1149 mechanisms. The agencies should conduct a similar program for natural gas programs. If an assessment indicates substantial increases in electric funding and authorities are needed, this would indicate legislation may be needed in the 2007 session.

Similarly the State should review the effectiveness of BPA and COU energy efficiency programs and whether the State's programs are consistent with and supportive of comparable efficiency efforts among non-regulated utilities (see EE-1e below).

Through legislation, allow homebuilders to take state Residential Energy Tax Credits (RETC) for heat pump water heaters (HPWH), solar photovoltaic (PV) and solar domestic hot water (DHW). Currently, only the homeowner is allowed to take the credit. With this change, either the builder or the homeowner could get the RETC. The NWPCC estimates that the region could acquire 195 aMW of cost-effective savings from HPWH by 2025. Oregon's share of this would be 64 aMW, which would reduce annual CO_2 emissions in 2025 by 0.35 MMT CO_2. This measure will make an important contribution to achieving the NWPCC target for heat-pump and solar water heating.

Solar PV and solar DHW savings are not included in the NWPCC plan, as the plan estimates these measures are not currently cost-effective. Savings or production from solar PV would be in addition to the NWPCC goal. Savings from solar DHW are included in the 195 aMW of savings, because homes will have either a solar DHW or HPWH system, but not both.

For new homes built on speculation, the builder is the decision-maker on whether to integrate HPWH, solar PV or solar DHW systems. Integration is less expensive than adding these systems later. This would require a statutory change, but it may not be controversial.

EE-1b: Upgrade Oregon building codes to reduce energy use by at least 15 percent by 2015 (building shell measures).

Amend the energy portions of the residential and commercial building codes for shell measures that address exterior structure walls, ceilings and floors to save energy. Because technologies continue to change, Oregon needs additional revisions to its building codes. Significant additional cost-effective savings are possible. As an example, many new or refurbished commercial buildings do not operate properly. Today's building energy systems are complex and should be commissioned (certified) to ensure they perform properly as designed.

ODOE estimates that structural codes improvement (shell measures) from 2005 through 2025 could save 63 aMW of electricity for a savings of 0.37 MMT CO_2 in 2025 at the assumed displaced generating mix of 50-50 natural gas and coal plants. ODOE also estimates that CO_2 savings in natural gas heated homes and commercial buildings could be 0.15 MMT CO_2. These savings include building commissioning and increased enforcement measures described below and are included in the energy efficiency forecast. Achieving these savings requires a stronger change in state policy than achieving the energy efficiency savings in EE-1a above. Oregon currently has substantial energy efficiency incentives such public purpose charges for investor-owned utilities, consumer-owned utility programs and state tax credits and loans. Residential and commercial building codes should be upgraded to reduce energy use and costs on a schedule to meet or exceed the target of at least 15 percent savings by 2015 recently set by the staff report of the West Coast Governors' Global Warming Initiative. Otherwise, building users will miss cost saving opportunities from new technologies.

Require commissioning certification of new buildings and major renovations. The major barrier to requiring commissioning by code is that code officials don't have the time or expertise to verify that building systems are operating as designed. A viable alternative is a seal of approval from an accredited (certified) commissioning agent. Oregon, Washington, and California should work together to develop commissioning and certification standards that would be incorporated into building codes. These standards could be developed in cooperation with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the Building Commissioning Association. This would also facilitate re-commissioning of existing commercial buildings. This could be relatively easy, if done cooperatively with California and Washington. This program is likely cost-effective. This would also help achieve cost-effective conservation in new gas- and oil-heated commercial buildings.

Support the infrastructure for enforcement of building energy codes. Codes only save energy if compliance is met. Among competing priorities, energy efficiency is often overlooked. There should be a renewed effort to provide information and training for code officials, designers, contractors, equipment vendors and others on energy code requirements and the benefits of energy efficiency. These measures would be cost-effective.

EE-1c: Amend building codes to set minimum space and water heating/cooling standards.

Amend the residential and commercial building codes to require minimum efficiencies for space heating/cooling and water heating/chilling based on cost-effectiveness and modeled after California equipment standards.

Oregon, Washington and California have long been leaders in building energy codes. Federal standards preempt state standards for some equipment, but not all. Failure of the federal government to set standards for several types of equipment allows Oregon, along with other West Coast states, to set equipment standards in codes. To date, Oregon building codes generally have not addressed equipment standards.

It would be cost-effective to raise the minimum efficiency of the equipment through changes in the building code. The Building Codes Division has no plans to do this. Also, Oregon currently has no efficiency certification or compliance-monitoring infrastructure for implementing standards, but may be able to adopt California protocols. This is an element of WCGGWI recommendations (see EE-1d below). ODOE estimates this measure will reduce CO_2 emissions in 2025 by 0.09 MMT CO_2 at the assumed displacement of a 50-50 gas and coal plant mix.

EE-1d: Adopt state appliance and equipment efficiency standards for Oregon.

Propose legislation for state appliance efficiency standards (California standards) that cannot be covered under the building code. Federal appliance efficiency standards could be achieving higher levels of cost-effective conservation. Federal standards preempt state standards for some appliances, but not all. California, Washington and Oregon are jointly exploring efficiency standards for appliances and equipment that cannot be covered by building codes. Appliance standards for products outside the scope of building energy codes would require legislation. This legislation will likely be controversial. The legislation would have to provide a mechanism for product efficiency certification (possibly by relying on California's certification program and database) and for compliance monitoring. These actions would be cost-effective. In the WCGGWI, the staff report recommends that all three states adopt energy efficiency standards for 8 to 14 products not regulated by the federal government, establishing a cost-effective efficiency threshold for all products sold on the West Coast. ODOE estimates this measure will reduce CO_2 emissions in 2025 by 0.41 MMT CO_2 at the assumed displacement of a 50-50 gas and coal plant mix.

EE-1e: Advocate with BPA and Oregon electric consumer-owned utilities to meet the NWPCC goal.

Continue Oregon and NWPCC efforts to work with the BPA and COUs to assure programs or incentives for effective energy efficiency programs. COUs account for 28 percent of the electricity sold in Oregon. Achieving the NWPCC goal in these areas will save 212 aMW and 1.24 MMT CO_2 at the assumed mix of new generation. Recent funding levels by BPA and Oregon COUs are comparable to the public purpose charge for PacifiCorp and PGE. BPA is evaluating its funding levels for 2006-2011.

This will require effective programs for Oregon COUs, either run by BPA or by the utilities themselves. It is recommended that the governor's office follow the regional dialogue on this issue and make recommendations to BPA if necessary. Continued coordination among the existing and new programs of ODOE, ETO, BPA and Oregon COUs is also needed.

EE-1f: Support OPUC actions to evaluate Northwest Natural energy efficiency programs.

Support Oregon PUC's reexamination of Northwest Natural's gas utility efficiency programs and ODOE's energy efficiency programs and modify where cost-effective. This measure would evaluate the success of ETO's programs for NW Natural and ODOE's gas energy efficiency programs. The ETO has a goal of 1.9 trillion annual Btus (TBtu/year) by 2012. Extrapolated, this would imply savings of 4.6 TBtu per year in 2025 or 0.24 MMT CO_2 per year. More cost-effective savings may be possible through higher levels of ratepayer funding of utility marketing and information programs, better coordination with ODOE programs, increasing the level of NW Natural's public purpose charge, or by expanding or modifying ODOE programs. The PUC could examine how to improve the marketing of ETO programs to NW Natural's customers. This might involve increasing the overall level of funds for marketing and information or adjusting the balance of funds between the ETO and NW Natural's efforts. Whether these changes are possible or needed would be determined by a joint study of the OPUC, ODOE and ETO. Because the public purpose funding for NW Natural is not in statute, legislation would not be required to change it.

This evaluation could also involve filling gaps between ETO's gas program for NW Natural and ODOE school gas programs. ODOE's K-12 schools program (under SB 1149) for all fuels does not cover schools in COU territories. ETO programs for NW Natural cover some of these COU areas, but don't have targeted COU schools programs.

Substantial changes in ODOE programs would likely require legislation in 2007. Currently, the OPUC has a program that automatically compensates NW Natural for most of the revenue lost due to reduced sales from energy efficiency programs. If not for this program, conservation would reduce NW Natural profits. Before this program, lost revenue had discouraged NW Natural from aggressively pursuing conservation. Continuing this program is likely necessary for conservation to succeed. Doubling the implied ETO goal would reduce NW Natural's 2025 emissions by 0.24 MMT CO_2 per year.

EE-1g: Advocate with OPUC for Avista and Cascade natural gas utilities to meet energy savings goals comparable to NW Natural.

Recommend the OPUC institute programs for Avista and Cascade that resemble those of NW Natural (See EE 1f). Together these utilities sell 19 percent of the natural gas sold by utilities in Oregon. NW Natural sells the remainder. The OPUC and these utilities could adopt a public purpose charge to fund ETO programs and could also remove rate-making disincentives that inhibit pursuit of cost-effective efficiency measures. Extrapolating the savings of NW Natural to these utilities yields a reduction in 2025 emissions of 0.05 MMT CO_2 per year.

EE-1h: Advocate for federal equipment and appliance standards.

Advocate for federal appliance and equipment standards that fully capture cost-effective energy efficiency. In recent years the federal government has decided not to apply its standards to several types of equipment and appliances and has not included all cost-effective savings in recent changes to appliances and equipment it does regulate. For example, the U.S. Department of Energy's attempt to weaken federal air conditioner standards in 2001 was overturned by federal courts. States have successfully lobbied for tougher standards in the past. Also, having state standards for non-regulated products has goaded federal action to avoid multiple state standards.

Federal standards and programs have been effective in reducing the economic impacts of electric price spikes and the high cost of imported natural gas and oil, as well as reducing CO_2 emissions. Oregon should vigorously support continued improvements in federal appliance and equipment efficiency standards. ODOE estimates that full implementation of cost-effective standards for federally covered appliances would save Oregon 55 aMW and 0.32 MMT of CO_2, assuming a 50-50 mix of new coal and gas-fired generation. Gas savings are estimated to be 0.08 MMT of CO_2.

EE-1i: Strengthen state marketing and public information of energy efficiency and incentive programs.

Improve marketing and public information for incentive programs. In cooperation with state agencies, local governments, utilities and conservation organizations, Oregon could enhance the effectiveness of public information, marketing and branding of energy efficiency efforts. This could involve a Governor's awards program.

EE-2: Support OPUC and COU efforts for modified electric rate designs to reflect daily and seasonal peak demand.

Support efforts by the OPUC and COUs to re-examine rate design measures that reflect daily and seasonal peak demand and reduce CO_2, and implement where cost-effective. Savings for these potential programs would be in addition to Oregon's share of the NWPCC goal of a 2,880 aMW reduction in electrical sales.

Electricity – Voluntary Peak Shaving: Examine voluntary demand-response (peak-shaving) rates and programs for PGE and PacifiCorp in Oregon and implement where cost-effective. These reduce CO_2 emissions because the gas-fired power plants that meet peak loads are the least efficient. This could be ranked as easy to accomplish, because the OPUC has adopted this goal. This measure might save an annual 0.05 MMT CO_2 in 2025.

Electricity – Residential: Redesign residential rates to reflect better the higher costs of electricity during peak seasons or times. Revise PGE's residential rate design from flat rates to rates that increase with use (inclining block rates). Revenues from the higher prices for higher use levels would be refunded to ratepayers through a lower price for the initial rate block. This could be ranked as easy. PacifiCorp's Oregon residential rates already have this feature. This measure might save 0.11 MMT CO_2 in 2025.

EE-3: Support OPUC actions for natural gas and fuel switching.

Support efforts by the OPUC and others to re-examine fuel switching to natural gas to reduce CO_2 and implement where cost-effective. Savings for the electric water heater program would be in addition to Oregon's share of the NWPCC efficiency goal, roughly estimated as 960 aMW.

Electric Water Heaters to Gas: Examine gas utility programs that would convert residential electric water heaters to gas and implement where cost-effective. The OPUC approved the concept in October 1991, but the program was not implemented due to concerns that most of the incentives would go to households who would have switched anyway (the so called free-rider effect).

A new issue would be the relative cost-effectiveness and CO_2 savings of switching existing electric-resistance water heaters to gas water heaters or heat-pump electric water heaters. The OPUC has adopted an objective to: "Investigate whether to promote the direct use of natural gas to meet customer needs over its use to generate electricity for that purpose." Savings in 2025 from this program would be 0.09MMT CO_2 per year at the assumed mix of new generation of 50-50 coal and gas plants.

Commercial Oil Boilers to Gas: Examine gas utility programs to convert existing commercial oil-fired boilers to efficient gas-fired boilers and implement if cost-effective and if the increased gas utility sales revenue would cover program costs. This could be controversial, especially among oil dealers. Savings from this program in 2025 would be 0.01 MMT CO_2 per year.

Electric Generation and Supply Actions to Reduce Greenhouse Gases

Issue: Oregon electricity supplies, once nearly all renewable (hydro), are now over 40 percent from coal and another 8 percent from natural gas. The latter two emit CO_2 and other greenhouse gases (GHGs) in combustion (although gas has lower emissions).

Solutions: To reduce GHG emissions, we must use all energy more efficiently, while meeting new load growth and replacing existing fossil fuel generation with energy efficiency and generation that does not produce GHGs.

Table 1 (GEN)

CATEGORY I: SIGNIFICANT ACTIONS FOR IMMEDIATE STATE ACTION		MMT CO_2E 2025	C/E?
GEN-1	Increase the renewable content of electricity.	0.80	Y
	GEN-1a: Increase retail energy sales from renewable resources by one percent or more annually in Oregon through 2015.		
GEN-2	Recommend the Governor create a special interim task force to examine the feasibility of, and develop a design for, a load-based greenhouse gas allowance standard.	At least 7.0*	?
	GEN-2a: The GEN-2 interim task force should also consider an Oregon Renewable Portfolio Standard (RPS) and potential changes to public purpose charges as tools to meet a greenhouse gas allowance standard and overall state CO_2 goals.		?
GEN-3	Support the Oregon Public Utility Commission's review of rules and tariffs for renewable and combined heat and power facilities.	0.54	Y
CATEGORY II: OTHER IMMEDIATE ACTIONS			
GEN-4	Encourage state government to purchase renewables.	0.08	N?
GEN-5	Advocate for specific federal policies or legislation.	varies	varies
GEN-6	Advocate with BPA to support Oregon's renewables measure.	varies	varies

Generation mix affects efficiency saving. In the table above, column three shows estimated CO_2 equivalent savings in million metric tons (MMT) through 2025. Column four asks if the action is cost-effective (C/E) - yes (Y) or no (N) - to the consumer over the action's lifetime. (This does not address whether it is cost-effective to Oregon and Oregonians broadly, considering the projected effects of global warming and the costs of adapting to those effects.) A question mark means that the estimates of cost-effectiveness are uncertain and more analysis is needed. The estimates assume displaced generation at a 50-50 mix of gas-fired and coal-fired generation. Refer to Figure 8 in Part Two, Section 1 (Introduction to Recommended Actions) for the cumulative impact of actions.

** Assumes a carbon constraint at least equal to an RPS of 25 percent.*

GEN-1: Increase the renewable content of electricity.

The forecast mix assumes Oregon will implement the final versions of the Oregon Renewable Energy Action Plan (currently in draft form) and the West Coast Governor's Global Warming Initiative (WCGGWI). This could have small fiscal impacts. The draft Oregon renewable plan calls for completing the following new renewable energy actions in calendar year 2005 and 2006:

- 300 megawatts (MW) of new wind energy capacity, of which 10 percent will be from community or locally-owned projects
- Effective solutions to the transmission capacity bottleneck(s) between Eastern and Western Oregon to provide access to renewable and other resources in Eastern Oregon to load centers
- Have all electric utilities offer a "stable price" renewable energy product to customers.
- 500 additional solar photo-voltaic electric installations (about 1 new MW)
- 25 MW of new biomass-fueled electric generation built or under construction (of which 5 MW will be from new biogas generation facilities from wastewater treatment, dairies and landfills)
- 25 MW of efficient new combined heat and power generation systems built or under construction
- 1 MW of new fuel cells
- 20 MW or more of geothermal generation projects built or under construction
- 1 to 4 MW of additional environmentally sustainable hydroelectric capacity in the process of being developed (primarily irrigation piping channels)
- An assessment of the feasibility of a renewable portfolio standard (RPS) for Oregon

These projects will produce about 150 average megawatts of electric energy. This is about 50 percent more than the load for the city of McMinnville. This would raise the fraction of loads met by non-hydro renewables to 5 percent. These measures, other than wind, will likely require additional staff of about 3 full-time employees (FTE). The staff could be spread out over several natural resource agencies or a single natural resource agency. These staff would primarily draft and oversee federal grants. Initially, this would require general funds, but after successful grant awards, only the grant writing portion would require general funds for about one FTE.

The generation mix is based roughly on the Northwest Power and Conservation Council draft mix that includes reduced load growth from energy efficiency actions applied in Oregon. The mix also assumes the equivalent of the Oregon Energy Facility Siting Council's (EFSC) CO_2 standard being applied gradually throughout the West. The resource additions listed above save 0.80 million metric tons (MMT) of CO_2 per year starting in 2006, assuming the displaced mix is half new coal-fired plants and half new natural gas-fired plants. Short-term impacts on power plant operations are similar because existing plants with higher fuel costs and CO_2 per kWh are displaced first when renewable resources are added.

GEN-1a: Increase retail energy sales from renewable resources by one percent or more annually in Oregon through 2015.

The WCGGWI (See Appendix E) calls for Oregon, Washington and California to set goals and implement strategies and incentives to increase retail electricity sales from renewable resources, adding one percent of load or more annually in each state through 2015. This is consistent with a path to meeting 20 percent of load with renewables by 2020 (not including large hydro-electric generation). Savings for this element of GEN-1 are included in GEN-2 below.

GEN-2: Recommend the Governor create a special interim task force to examine the feasibility of, and develop a design for, a load-based allowance standard.

This standard would reduce total amounts of CO_2 and other GHG emissions due to consumption of electricity, petroleum and natural gas by Oregonians in a deliberate, predictable, effective, equitable and verifiable manner. The task force should be directed to provide the Governor with its recommendation in time for legislative action, if necessary, in the 2007 session.

The task force should include a fair representation of parties with economic and environmental interests at stake, along with appropriate state agency staff and legislators. The long-term (2050) goal should be to reduce GHG emissions from all sources to levels that are consistent with a state goal of climate stabilization emissions levels. A secondary goal should be to capture and reinvest or equitably distribute economic benefits from energy efficiency, renewables and bio-sequestration strategies. Tools may include: utility and government resource programs (including those of the ETO and BPA's transmission and integration capabilities); government tax, long-term financing and incentive programs; and offsets and trading. Barriers to meeting allowance goals should be identified and addressed including current state regulatory signals if appropriate.

At a minimum the task force should address the following questions:

1. **Long-Term and Interim Sector Allowances:** What long-term (2050) sector GHG emissions allowances should be set for electricity, gas and oil (consistent with an overall State of Oregon GHG emissions goal)? What *interim* emissions levels should be set (e.g., what are the shape and slope of the compliance curves) that are feasible and allow deliberate, but not delayed, action? What intervals should be set for interim compliance? Should there be a brief "beta" period at the beginning of enforcement of the cap to test accounting principles and other mechanisms, during which greater compliance flexibility would be permitted?

2. **Different Fuels and Suppliers:** How can equitable standards and/or program options be applied to diverse energy sources (electricity, natural gas, petroleum) and suppliers (including public- and investor-owned utilities, non-utility suppliers and self-generators)? Should compliance curves be identical for all suppliers or different to reflect different supplier circumstances? Should other significant non-energy emitters of GHG's (e.g., industrial emissions) be incorporated into this mechanism, or will they require a different one?

3. **Emissions Credits Trading:** Should – and could – such a system be designed to incorporate features compatible with a regional emissions trading mechanism between Oregon and its West Coast partners (Washington and California) on the premise that the wider the market, the more efficiently it should function? Between the West Coast and the Eastern states? Could we design a system that includes and harnesses the initiative of non-utility contributors (e.g., renewable resource developers and others who do not emit GHGs and would not therefore receive an allocation to use or trade)?

4. **Compliance Flexibility:** How can such a system be designed to allow sufficient compliance flexibility – including trading, acquiring offsets from energy efficiency, renewable energy and/or GHG sequestration, and financial off-ramps – while still achieving real reductions of GHG emissions and a transition to a low-carbon energy supply system? Can we quantify these different kinds of contributions in comparable and tradable units? Can we, while avoiding being prescriptive, ensure a diverse portfolio of responses? How can we credit the appropriate utilities and ratepayers for the contributions of non-utility participants such as the Energy Trust of Oregon?

5. **"Leakage":** How can such a system be designed to withstand "leakage" or gaming resulting from reallocation of generating resources across state boundaries? In particular, is there a way to account for new and existing resources among the states PacifiCorp serves, so that Oregon emissions reductions do not translate into emission increases elsewhere in the PacifiCorp system?[19]

6. **Economic Development:** How can such a system be designed to capture economic development benefits for Oregon including developing technologies, products and services for marketing outside the state? How can it be designed to reinvest energy efficiency savings into new job-creation and carbon-saving investments? Can we devise strategies for reconciling such investment objectives with the goal of keeping compliance costs manageably low?

7. **Protecting Oregon's Competitiveness:** How can a system be designed to capture the economic gains of Oregon's investments in GHG mitigation, while avoiding loss of competitiveness in energy pricing between Oregon and its neighbor states or other competitors? If there are near-term rate effects – costs or benefits – how can they be allocated in an equitable manner? How can a "safety valve" be designed into the system to create temporary breathing room to respond to critical competitiveness issues, energy market price spikes or other unanticipated and transient pressures?

8. **Federal Preemption:** Could such a mechanism be fitted with an automatic response – that is, an "off-ramp" – in the event of meaningful federal action that could constitute preemption. What should be considered "meaningful" federal action?

[19] Both this leakage issue and PacifiCorp's concerns about inconsistent state-by-state treatment could be addressed, in part, if Washington and California were to adopt compatible emissions credit trading mechanisms.

The discussion below focuses on CO_2, the principal GHG emission from fossil fuel and electricity use. To stabilize CO_2 concentrations in the atmosphere at roughly double pre-industrial levels, world-wide CO_2 emissions will have to be reduced by 60 to 80 percent of the 1990 rate this century. Cumulative CO_2 emissions over the 21st century are the key variable. This is the only proposed option other than a CO_2 tax that could reduce Oregon's electric emissions below the 1990 level. Other energy efficiency and generation actions primarily impact the amount and mix of new generating plants. If adopted, this measure could provide substantial incentives for renewable resource development, which would make Gen-2a (a Renewable Portfolio Standard or RPS) unnecessary. Alternately, an RPS could be enacted as one tool to assist the State and energy suppliers in complying with the allowance curve. The measure could also address the risks to Oregon's utilities and ratepayers of likely future carbon regulation affecting new coal plants.

To stabilize climate in this century requires reducing emissions from existing power plants. Some older coal-fired plants will be almost 100 years old in 2050. Without new regulations, these plants might continue to operate past 2050.

Clear long-term guidance on CO_2 is needed for utility planning. Utilities are considering retrofits at coal plants to reduce emissions of criteria pollutants (e.g., subject to Clean Air Act constraints) and mercury. If utilities face clear CO_2 emission limits in the near future, they can avoid wasting money upgrading the oldest coal-fired power plants and later having to shut them down because of CO_2 regulations.

To begin to address the difficult long-term issues, Northeast and Mid-Atlantic states are considering a regional cap-and-trade system for electric CO_2 emissions. Depending on how an Oregon or West Coast allowance mechanism is designed, Oregon and other West Coast states might be able to participate with an East Coast trading system and lower costs to achieve the needed emissions reductions.

Eastern states are designing a system based on allocations to generating plants located in their states. Designing allowances on GHG emissions for only those power plants located in Oregon would be inequitable for the state's two largest utilities. PGE has most of its fossil-fueled generation facilities in Oregon, while most of PacifiCorp's plants are in other states. Even though the disparities are less severe in the Northeast, this problem is serious enough to consider a different kind of cap.

Another problem with an allowance solely for in-state plants is that it might only encourage new power plants to be built outside of Oregon as it becomes more stringent. If so, this would only harm Oregon's economy with no reduction in CO_2 emissions.

Rather than a system based on generating plants located in Oregon, this action would develop a system to allocate emissions from utility power plants and purchases to their Oregon load and set limits on those emissions. This system is sometimes referred to as a load-based cap-and-trade system. It would be consistent with Oregon's CO_2 accounting system and the Oregon Public Utility Commission's (OPUC) labeling requirements for PacifiCorp and PGE.

Such a limit would be on total tons of utility CO_2 or GHG emissions, calculated by the pounds per kWh of utility generation sources multiplied by kWh of load during an accounting period, such as annually. The limits could be designed to provide the appropriate trajectory of utility emissions for the 21st century. The limits for early years could be near existing emission levels. The limit would be reduced on an established, predictable curve through 2050 to achieve the desired mid-century emissions levels.

An alternative is to set limits only on the emission rates (pounds of CO_2 per kWh for each load-serving entity) rather than total CO_2 tons emitted. This is referred to as an emissions portfolio standard (EPS). While more comprehensive than a Renewable Portfolio Standard (see Gen-2a below), an EPS does not ultimately limit total emissions and would not incorporate emissions reductions from energy efficiency actions.

A greenhouse gas allowance system (unlike an EPS, an RPS or a ban on new coal plants) should be designed to allow utilities to minimize the cost of meeting an emissions target. An allowance system may allow explicit consideration of imported power and recognition that new gas-fired generation may serve to reduce overall average emissions from electricity generation and may also complement new, intermittent renewable generation such as solar and wind. If one utility has lower-cost energy efficiency or generation options, it can reduce its emissions below its allowance and sell allowances to another utility or load-serving entity. This trading could occur between East Coast and West Coast utilities if states adopted a coordinated system. It could also include appropriately designed project offsets. Allowing the use of project offsets can help limit the costs of meeting the limits on CO_2 emissions.

There are many details to be worked out. For example, utility limits would need to deal with loss of load through changes in utility service territories or customers choosing retail access suppliers. The design of the Oregon system should be coordinated with other states wherever possible.

GEN-2a: The GEN-2 interim task force should also consider an Oregon Renewable Portfolio Standard (RPS) and potential changes to public purpose charges as tools to meet a greenhouse gas allowance standard and overall state CO_2 goals.

Through legislation, substantially expand the amount of new renewable power projects. This could serve as a strategy to implement Gen-2 (above) and to be considered by the special interim task force that examines the feasibility of, and develops a design for, a load-based GHG allowance mechanism. This option could be accomplished with a renewable portfolio standard (RPS) complementing the existing public purpose charge for renewables. If applied in support of GEN-2, an RPS could help provide a better balance in the types of renewables. The mix should include small amounts of promising, but relatively expensive, renewable sources. This could help achieve aggressive long-term GHG emission goals. An RPS, together with Oregon's existing public purpose funding mechanism, can help achieve an appropriate mix and pace of renewable development.

The fraction of load-growth met by renewable resources could be increased by adopting an RPS for Oregon electric utilities and other retail electric suppliers. Another approach would be to expand the 0.5 percent renewable portion of the public purpose charge applied to PGE and PacifiCorp retail electric bills from SB 1149 (1999 session). In either case, the 0.5 percent renewable public purpose charge should not be repealed entirely, because part of the funds go to renewables such as solar photovoltaics. These are expensive now, but have good long-term potential.

There are several states with an RPS that could serve as a model. A poorly devised RPS could imply action but be ineffective. Any RPS legislation would have to address several issues. These issues include:

- Resource eligibility (perhaps including separate targets for resources or sub-resource technologies within each category; inclusion of hydro and definitions of biomass tend to be controversial)
- Vintage (only projects built after a specific year)
- Size of targets (absolute capacity or energy, percent of load, or percent of load growth)
- Timing of targets (deferred until a time when loads have grown or fixed targets for specific years)
- Compliance paths (whether to require bundled power purchases or whether to allow renewable energy certificates or "green tags")
- Price or cost caps (absolute or pegged to shifting market values)
- Covered entities (all utilities or investor-owned only, inclusion of retail access suppliers)
- Geographic eligibility (in- and out-of-state plants or in-state only)
- Banking (carryover from over-compliance years to future years and true-up provisions)

This legislation would be highly complex and controversial. It may be perceived as violating the legislative intent of SB 1149. If so, this could lead to repeal of the renewable portion of the existing system benefit charges.

Having a 15 percent RPS by 2025 (as percent of 2025 load) would reduce annual carbon dioxide emissions between 3.6 MMT CO_2 (if it had the effect of banning new coal-fired power plants), and 2.8 MMT CO_2 (if it did not). A 25 percent RPS would fulfill all new baseload requirements and displace some existing gas- and coal-fired generation under the energy efficiency case forecast of one percent annual load growth. Estimated savings are 7.0 MMT CO_2 in 2025.

An RPS could be designed with earlier implementation for earlier savings, but an RPS is generally designed to address only new power plants that serve load growth. An RPS that acquires more electricity than is needed for load growth would necessarily back down existing generating plants, either utility-owned or purchased. However, without further direction, the plants where reductions occur may not be the least-cost source of CO_2 reductions. Emissions from existing plants would be better addressed by a load-based cap and trade system.

GEN-3: Support the Oregon Public Utility Commission's (OPUC) review of rules and tariffs for renewable and combined heat and power (CHP) facilities.

Support Oregon PUC's review of rules and tariffs to ensure they accurately reflect the costs and benefits to the utility system from CHP systems, also called cogeneration, especially within the distribution system. Also recommend that consumer-owned utilities conduct similar reviews. This should increase the number of CHP systems, especially efficient gas-fired technologies, which have lower CO_2 emissions than stand-alone gas generation and much lower emissions than coal plants. This requires action by an independent board or commission, but could be ranked as easy because the OPUC, which covers 72 percent of Oregon load, has begun this process. The emissions reduction in 2025 could be 0.54 MMT CO_2 per year assuming displacement of 200 average megawatts of the assumed mix of half coal and half gas-fired power plants.

GEN-4: Encourage state government to purchase renewables.

Suggest that the Governor establish a 2005-2007 budget for renewable purchases by state agencies. This could be through a "one percent for renewables" requirement for new state and university buildings (similar to the "one percent for art" program) or through state purchase of renewable power or renewable energy certificates (green tags) without the power. Spending the funds on visible technologies in new buildings, such as solar photovoltaic (PV), daylighting or ground-source heat systems, might increase public awareness and advance distributed renewable technologies more than purchases of renewable power. A combination of new building measures and purchases is possible. These options would require legislative approval of funding, but might not be controversial, depending on the level of funding.

Buying renewable power, along with renewable energy certificates, would insulate state energy bills from future fossil fuel cost increases or CO_2 regulations. If the State buys only the certificates, it would reduce the added costs to state government for the same number of megawatt hours of renewable claims by the State, but would not provide the price stability benefit.

Eugene Water & Electric Board (EWEB) is the only utility or retail electricity service supplier (ESS) that offers a fixed-price renewable product. The City of Portland is exploring this idea with Portland General Electric, either as a utility product or with PGE helping shape a renewable product from an ESS. If state government pursues this idea, it should be in collaboration with the City of Portland.

This measure refers only to costs of renewable energy in excess of the expected market price of electricity or fuel. Even if renewable resources are more expensive than expected market purchases, they would help insulate future state budgets from electric and natural gas price spikes. If actual fuel or electricity prices are higher than expected, these actions would reduce the cost of state operations over the lifetime of the buildings. It is unlikely fuel or electricity prices will be substantially below current levels. The 2000-2001 West Coast energy crisis showed that upside price risk is nearly unbounded.

During the last 15 years, the State spent about a billion dollars on new state buildings. One percent of this would be about $670,000 per year. For comparison, spending this same amount on the above-market cost of electric renewables purchases would make about one-third of the state government's power renewable (assuming renewable power costs $5/MWh more than wholesale market power). This would add 2 to 3 percent to the State's electric bill. This would save 0.08 MMT CO_2 per year if the displaced mix of new generation were half coal and half natural gas-powered plants.

GEN-5: Advocate for specific federal policies or legislation.

State agencies could advocate for federal policies (U.S. DOE and EPA) on:

- energy tax breaks (including the renewable production tax credit);
- a Renewable Portfolio Standard;
- CO_2 caps (such as the McCain-Lieberman Climate Stewardship Act);
- CO_2 or other energy taxes;
- budgets for research, development and demonstration;
- appliance and equipment efficiency standards;
- biological and non-biological sequestration research and programs; and
- material use/recycle/disposal research or programs.

For critical legislative issues the Governor could work with the Oregon Congressional Delegation.

GEN-6: Advocate with Bonneville Power Administration (BPA) to support Oregon's renewables measure.

BPA's role in the Northwest since the passage of the NW Power Act of 1980 has been to support development of resources designated by the Act as higher priority (conservation and renewables) through direct acquisition, customer utility programs, products and transmission services. BPA's role is particularly pivotal with COUs, many of whom are small and reliant on the services the larger federal agency can provide.

BPA owns and operates the largest part of the Northwest transmission system and manages and dispatches output from the Federal Columbia River Power System. BPA also has the greatest capability to integrate and firm up intermittent generating technologies such as wind.

Oregon's renewable generation actions will be more effective if BPA continues to actively provide such support. Oregon should work with BPA in the following areas: a more effective Conservation and Renewable Discount, transmission sufficiency, affordable integration services, power rate designs that provide incentives for COUs to develop renewable resources; new non-firm and "near-firm" transmission products; and strategic renewable resources acquisitions. For critical issues, the Governor could support BPA through intervention with the Oregon Congressional Delegation.

Transportation Actions to Reduce Greenhouse Gases

Issue: One-third of Oregon's total greenhouse gas (GHG) emissions are from vehicle exhaust. Cost-effective opportunities to reduce these emissions are available, particularly in urban areas.

Solutions: Two categorical solutions are: 1) to reduce GHG emissions from consumption of fossil fuels by displacing conventional combustion engines with hybrid, electric and other technological/fuel options, and 2) to guide land use choices, especially in Oregon's urban areas, toward more efficient choices including higher densities, transit options, mixed-use neighborhoods, and common wall dwelling designs.

TABLE 1 (TRAN)

Transportation Actions

CATEGORY I: SIGNIFICANT ACTIONS FOR IMMEDIATE STATE ACTION		Reductions in Greenhouse Gas Emissions in $MMTCO_2E$ 2025	C/E?**
TRAN-1	Convene an interim task force to recommend a proposal for the Environmental Quality Commission or the Governor and the Legislature to adopt emission standards for vehicles.		
	TRAN-1a: Adopt Low Emission Vehicle (LEV II) Emission Vehicle Standards.	0.24	Y
	TRAN-1b: Adopt greenhouse gas Tailpipe Emission Standards (per California AB 1493 "Pavley" standards).	> 6.0	Y
TRAN-2	Integrate land use and transportation decisions with greenhouse gas consequences.	0.40	Y
TRAN-3	Promote biofuel use and production.	1.0	Y
CATEGORY II – OTHER IMMEDIATE ACTIONS			
TRAN-4	Review and enhance state tax credits and local incentives for citizens purchasing high efficiency vehicles.	-*	?
TRAN-5	Incorporate greenhouse gas emission impacts into transportation planning decisions.	-	Y
TRAN-6	Expand "Transportation Choices Programs" and "Travel Smart Pilots."	-	Y
TRAN-7	Adopt state standards for high efficiency/low rolling resistance tires.	0.12	Y
TRAN-8	Reduce GHG emissions from government fleet purchase and vehicle use.	-	Y

TRAN-9	State and local governments should switch to "clean diesel" fuel, vehicle purchases and retrofits.	0.10	Y
TRAN-10	Adopt state and local incentives for high efficiency vehicles.	-	Y
TRAN-11	Set and meet goals for reduced truck idling at truck and safety stops.	-	?
TRAN-12	Set up traffic flow engineering "Best Practices."	0.08	
TRAN-13	Set and meet goals for freight (truck/rail) transportation efficiency; achieve this through equipment, coordination and land use.	-	?
TRAN-14	Establish consumer awareness education link to transportation choices.	-	Y
TRAN-15	Improve mass transit and inter-city transit links.		
	TOTAL	7.84	

** Symbol "-" denotes savings of less than .0001, or unable to be estimated.*
*** Column four asks if the action is cost-effective (C/E) - yes (Y) or no (N) - to the consumer over the action's lifetime. (This does not include whether it is cost-effective considering the projected effects of global warming.) A question mark means that the estimates of cost-effectiveness are uncertain and more analysis is needed. Refer to Figure 8 in Part Two, Section 1 (Introduction to Recommended Actions) for the cumulative impact of actions.*

Background

The goal of this effort is to reduce GHG emissions from transportation-related activities in Oregon. Oregon can achieve this goal by optimizing freight and people movement through the use of new technologies and diverse modes, land use planning and the use of low carbon-content fuel. As a result, Oregonians will live in a healthier environment and show leadership in meeting the challenge of global warming.

How we plan for our future and build our communities can reduce GHG emissions and bring other benefits. Communities can create a range of housing choices, mixed uses and a variety of transportation choices. Mixed uses can provide for more efficient use of buildings. Communities can plan for streets and land use in a way that creates livable, transportation-efficient communities. Providing safe streets for bikes and walking can lead to healthier lifestyles. Adults can walk or ride bikes to work and children can walk or ride bikes to schools. Such walkable neighborhoods create a strong sense of place. Strengthening development in existing communities through coordinated land use and transportation planning can help preserve open space, farm and forest lands, natural beauty, and critical environmental areas. Strengthening existing communities can also make transit a feasible alternative. Building upon existing infrastructure is also a more fiscally sound public policy.

Transportation and electricity use are Oregon's two largest contributors to GHG emissions – more than each of these other direct energy use sectors: industrial, commercial or residential. One-third of Oregon's GHG emissions is from transportation. Modes contributing to these emission levels include cars, light trucks, sport utility vehicles (SUVs), buses, large trucks, airplanes, trains and marine vessels. In Oregon there are over 3.1 million motor vehicles registered for roadway use. Oregonians spend more than $3 billion for transportation fuels each year.

A balanced approach is needed to improve Oregon's climate, air quality and transportation efficiency objectives. Alternative transportation fuels and better designed vehicles can provide lower emissions and insulation from petroleum price spikes. A reduction in emissions from all transport sectors can result in a more stable climate, cleaner air and more livable communities.

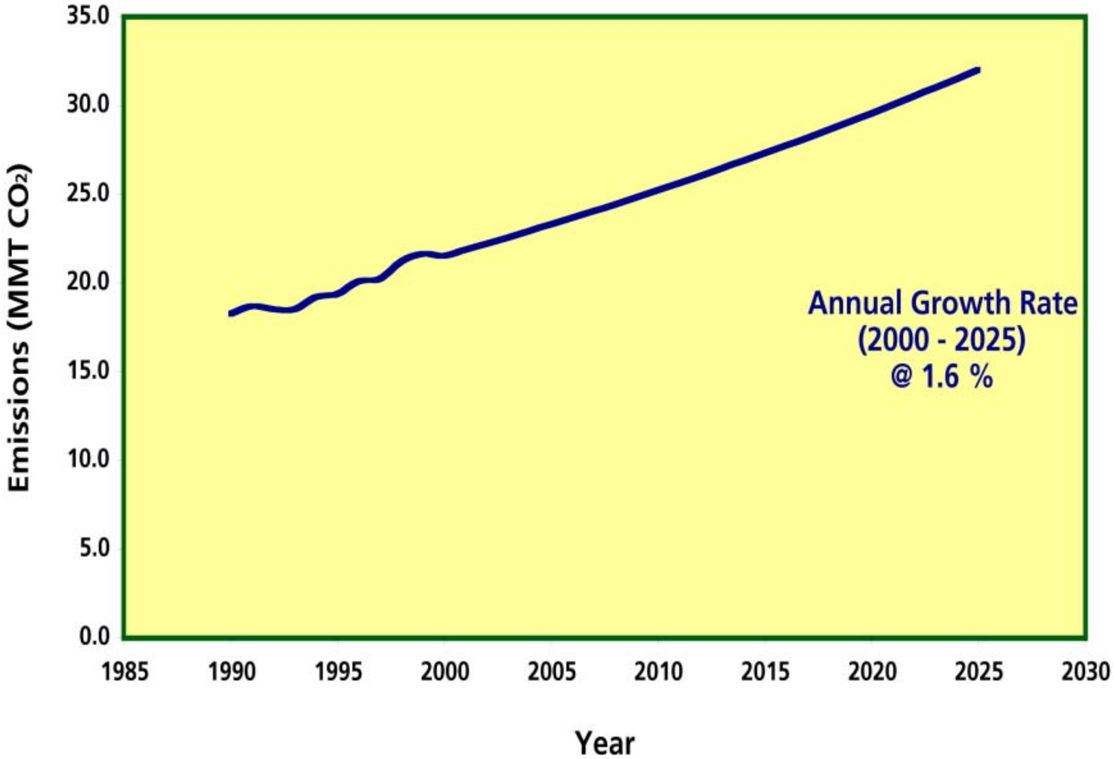
It is difficult to rank actions separately based on their GHG emission-savings potential. The rankings can be misleading for a number of reasons. For example, emission standards could be set at various levels, thus affecting the level of GHG savings from actions that reduce vehicle miles traveled. In addition, most of the following actions are listed exclusive of each other. However, it will be a combination of these ideas that will produce the greatest benefit.

Estimates of effectiveness rely upon key economic and behavioral assumptions, which are somewhat uncertain. Strategy effectiveness depends on vehicle emissions and upon the response of travelers to changes in fuel prices (price elasticity), non-monetary travel costs (i.e., time) and land use patterns. Alternative assumptions about economic parameters and determinants of travel demand can also lead to different policy impacts.

Current Emission Levels and Trends in the Transportation Sector

According to U.S. Department of Energy (USDOE) Energy Information Administration data, 1990 Oregon emissions were 18.3 million metric tons (MMT) of CO_2. By the year 2000, emissions reached 21.5 MMT CO_2, for an annual growth rate of 1.6 percent. Based on the Oregon Department of Transportation's forecast for taxed fuels and USDOE forecasts for jet fuel and freight diesel, the Oregon Department of Energy (ODOE) forecasts an annual growth rate of 1.6 percent, leading to emissions of 32.0 MMT CO_2 by the year 2025. The current transportation CO_2 emissions are forecast to grow 33 percent between 2000 and 2025.

Figure 1 (TRAN)
Historic and Projected CO_2 Emissions from Transportation Use in Oregon



TRAN-1: Convene an interim task force to recommend a proposal for the Environmental Quality Commission or the Governor and the Legislature to adopt emission standards for vehicles.

Specific Recommended Actions:

- TRAN-1a: Adopt Low Emission Vehicle (LEV II) Standards.
- TRAN-1b: Adopt greenhouse gas Tailpipe Emission Standards (per California AB 1493, "Pavley" standards).

Currently, Oregon adheres to emission standards (Tier 2 Program) for passenger vehicles set by the federal government. Under federal law, Oregon could adopt California's stricter tailpipe standards. Doing so would ensure that auto-makers selling passenger vehicles in Oregon could only sell vehicles that produce less air pollution and fewer global warming gases than the national average.

LEV II Standards: Current California emission standards fall under its Low Emission Vehicle II program requirements. The LEV II program establishes emission standards for all new cars sold in California or any state that adopts the program. These standards are designed to address criteria pollutants (non-methane organic gas [NMOG], nitrogen oxides [NO_x], and carbon monoxide [CO]). California first adopted its first Low Emission Vehicle (LEV) standards in 1990. They were aimed at lowering the emissions of passenger and light duty vehicles. The LEV standards ran from 1994-2003. LEV II regulations, running from 2004 to 2010, represent continuing progress in emission standards. New “Pavley” standards, discussed below, will apply to motor vehicles manufactured in 2009 and thereafter. Adopting LEV II before Pavley comes into effect means that the standards automatically progress from LEV II to Pavley.

New York, Massachusetts, Connecticut, Vermont and Maine have adopted the California LEV II emission standards under Section 177 of the Clean Air Act. In addition, the State of Washington is pursuing the adoption of LEV II standards. Canada, a Kyoto Protocol signatory and itself a significant part of the North American vehicle market, is also likely to adopt tailpipe standards identical or comparable to the California “Pavley” standards. Vehicles that meet those current standards (which do not include new “Pavley” standards) result in about a $200 added sticker price compared to federal standards.

The LEV II program consists of two components: the LEV requirement and the advanced technology vehicle program. Under the California standards, 90 percent of a manufacturer’s vehicle fleet is required to meet strict baseline emissions standards. Some studies have found that the emission standard for LEV vehicles, which is stricter than the federal standard, and can be achieved through the application of conventional pollution-control technology to the internal combustion engine. The remaining 10 percent of the vehicle fleet must be lower emitting than LEV standards, which qualify for credits under the advanced technology component of the program. The advanced technology components of the LEV II standards are summarized in the following table.

TABLE 2 (TRAN)
Advanced Technology Requirements of the
LEV II Emission Program, 2005-2008

Category	Vehicle Type	Examples	Percent of Total Fleet	Percent of Total Alternative Compliance
Gold	Pure-Zero Emission Vehicle (PZEV)	Electric vehicles and fuel cells	2	250 total fuel cell vehicles by 2008
Silver	Advanced technology (AT) ZEVs	High Efficiency Vehicle (HEV), CNG* vehicles	2	3
Bronze	SULEVs	Super Ultra Low Emissions Vehicle (SULEV)	6	6

*Compressed natural gas

AB 1493 (Pavley bill) Standards: In 2002, recognizing that global warming would impose compelling and extraordinary impacts on California, the legislature adopted and the Governor signed AB 1493. That bill directs the California Air Resources Board (CARB) to adopt regulations to achieve the maximum feasible and cost effective reduction of GHG from motor vehicles. The Pavley standards would take effect for the 2009 model year when the LEV II program expires.

The Pavley bill requires that the new regulations be economical to the consumer over the life cycle of the vehicle. Consistent with this direction, the technology packages that provide the basis for the standard result in operating cost savings that exceed the initial capital cost. This results in a net savings to the consumer over the life cycle of the vehicle.

On September 23, 2004, CARB adopted regulations that achieve "the maximum feasible and cost-effective reduction of GHG emissions" from passenger vehicles and light-duty trucks. The California legislation requiring CARB to develop these GHG regulations explicitly states that CARB cannot impose taxes or restrict speed limits, vehicle size, or other consumer driving choices. It also gives auto-makers flexibility in meeting GHG emissions targets.

The regulations will go into effect in January 2006 and will apply to motor vehicles manufactured in model year 2009 and thereafter. Criteria to be used in determining "maximum feasible and cost-effective" include: 1) the ability to be accomplished within the time provided, considering environmental, economic, social, and technological factors, and 2) the economy to vehicle owners and operators, considering full life-cycle costs of a vehicle. CARB is required to consider the technical feasibility of the regulations and to consider their impact on the state's economy including jobs, new and existing businesses, competitiveness significantly affected by air contaminants, automobile workers and related businesses in the state. CARB is also flexible, to the maximum extent feasible, in terms of complying with the regulations. CARB must ensure that any alternative methods for compliance achieve equivalent or greater reduction in GHGs.

Under the new Pavley standards, the average first cost increase will be about $367 per passenger vehicle in 2012 and about $1,064 per passenger vehicle in 2016. The retail vehicle price increase is slightly less for SUVs and large trucks. This range results from the phasing in of higher standards starting in year 2009 and continuing through 2016. By 2020 the estimated savings from maximum feasible technology will result in a reduction of about 18 percent in total GHG emissions from passenger cars and light duty trucks and a 28 percent reduction by 2030. Despite higher initial costs, vehicles that meet these standards are less expensive over the life of the vehicle.

The Oregon Environmental Quality Commission has the authority to adopt emission standards for passenger and light duty vehicles, however legislative support would likely be prudent. Therefore, the Governor might choose to ask the Legislature to adopt the standards, given the significance of the action. By adopting California's vehicle emission standards, Oregon will have in place a progressive standard to curb emissions from vehicles, which will have a significant impact on meeting the Oregon Progress Board benchmark on climate change and the new goals recommended by the Advisory Group.

TRAN-2: Integrate land use and transportation decisions with greenhouse gas consequences.

Specific Recommended Actions:

- Revise the Oregon Transportation Plan to consider and implement non-road alternatives before road capacity is expanded. Alternatives that could be implemented now include transportation demand management and expanded transit service. Intelligent transportation systems and value pricing can be considered for later implementation.
- When transportation plans are updated and air quality conformity determinations are required, calculate estimates of GHG emissions from transportation sources using EPA approved methods. Comparisons with earlier GHG emission forecasts should be made available to document change over time.
- Through local planning and state policy, target infrastructure investments in GHG efficient locations (locations where people's homes are located near the places they regularly go).
- Foster a Location Efficient Mortgage pilot program, such as Fannie Mae's Smart Commute™ Initiative to encourage home ownership near public transportation.

The primary purpose of integrating land use and transportation decisions is to reduce the need to travel (or reduce trip length) by providing nearby access to goods and services. The State should consider policies to further limit sprawl and encourage efficient development of residential, commercial and industrial lands.

This action supports continued integration of land use and transportation planning by incorporating "Smart Growth" principles in decision-making processes, particularly in application of Goal 12 and 13[20] for Transportation and Energy, respectively. Smart growth concepts related to transportation include:

- Promoting transit oriented development
- Mixed-use development
- Minimum street connectivity standards
- Minimum densities and/or minimum floor-area ratios and parking standards (e.g., reducing the minimum number of parking spaces required, employee cash payout programs and pricing parking)

Specific standards for the strategies listed above will vary by community.

The State could accelerate "smart growth" objectives by continuing to support the on-going implementation of the Transportation Planning Rule (TPR) and Transportation Growth Management program that provides funds to local governments to help carry out TPR planning.

[20] Oregon Land Conservation and Development Commission's 19 Statewide Planning Goals and Guidelines.

Studies of the vehicle miles traveled (VMT) impacts of integrated packages of land use and transportation measures have found regional and statewide VMT reductions ranging from 2-10 percent below business-as-usual projections, resulting in roughly equivalent CO_2 reductions (1 VMT equals about 1 lb. of CO_2 emitted).

TRAN-3: Promote biofuel use and production.

Specific Recommended Actions:

- Establish fuel standards that meet engine makers' requirements.
- Require nearly all diesel fuel sold in the state to contain at least 2 percent biodiesel (B-2) by the time Ultra Low Sulfur Diesel (ULSD) fuel is mandated by the federal government (mid 2006). ULSD requires the use of a lubricity additive; biodiesel is a non-toxic lubricity agent.
- All diesel fuel sold in Oregon will contain 5 percent biodiesel (B-5) by 2010, growing to 20 percent (B-20) by 2025. All biodiesel will meet applicable American Society for Testing and Materials standards.
- Adopt a statewide ethanol fuel requirement for all gasoline sold in Oregon, such as all standard gasoline sold in Oregon will contain 10 percent ethanol by 2010.
- Mandate a minimum biofuel content for all state-owned fueling stations; for example, 10 percent of the gasoline used by state government vehicles will be E-85 by 2010 and 20 percent of the diesel used by state fleet vehicles will be B-20 by 2010. This percentage will grow to 25 percent by 2025.
- Review the effectiveness of federal and state incentives for producers, blenders or retailers.

Recommended biofuels include biodiesel and ethanol that reduce GHG emissions. Biodiesel can displace conventional diesel with blends ranging from 2-100 percent. Blends up to 20 percent require no engine modifications. Ethanol can be blended with conventional gasoline up to 10 percent without any engine modifications. Blends using 85 percent ethanol (E-85) require slight engine modifications.

Biodiesel is a cleaner burning alternative fuel, produced from domestic, renewable resources. It contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications.

According to a USDOE/USDA life cycle analysis, biodiesel has the highest energy balance of any fuel. For every one unit of fossil fuel it takes to produce biodiesel, 3.2 units of energy are gained (using renewable fuel crops). That same study concluded that biodiesel also results in a 78 percent lifecycle reduction in carbon dioxide.

Ethanol alcohol fuel is usually mixed with gasoline at 85 percent ethanol and 15 percent unleaded gasoline to form what is called E-85. Currently, gasoline in Oregon has zero to 10 percent ethanol, with an overall average of 2 to 3 percent. No E-85 fuel is commercially available in Oregon.

Typically derived from distilling corn, ethanol is also a byproduct of starch manufacturing. Depending on the life cycle of the feedstock, how it is transported and the production process to make ethanol, ethanol from corn can reduce GHG emissions. Ethanol made from cellulose (e.g., woody crops, wood waste, switchgrass, agricultural residues, municipal solid wastes) generates substantially fewer GHGs than fossil fuels or ethanol made from corn, but the technology to produce cellulosic ethanol is not developed.

TRAN-4: Review and enhance state tax credits and local incentives for citizens purchasing high efficiency vehicles.

This action reviews and considers modifying the Business Energy Tax Credit and the Residential Energy Tax Credit programs to ensure that they are effectively promoting the purchase of more fuel-efficient vehicles. An incentive could be based on the fuel efficiency (miles per gallon) of the vehicle rather than a specific technology.

ODOE offers tax credits to assist the added costs of alternative fuel vehicles. These vehicles include those powered by ethanol, methanol, electricity, compressed natural gas, liquefied natural gas, liquefied petroleum gas, biodiesel, hydrogen, and hybrid vehicles.

Purchasing more efficient lower-emission gasoline-powered vehicles provides benefits similar to alternative fuels, most often at a lower first cost. The tax credit program could be reviewed to include fuel efficiency and polluting qualities of the vehicle, rather than the vehicle technology. The tax credit available to private citizens, now at $1,500 per vehicle, could be raised to parity with the credit available to businesses under the Business Energy Tax Credit program at about $2,000 per vehicle.

TRAN-5: Incorporate GHG emission impacts into transportation planning decisions.

Specific Recommended Actions:

- Develop a mechanism to better coordinate growth forecasts and Urban Growth Boundary decisions within each metropolitan area and adjacent “travel-sheds.”
- Develop a method to account for GHG emissions and use it as a ranking criterion in transportation planning decisions. (e.g., MOBILE 6.2 software)
- Communicate to the Oregon Road User Fee Task Force the need to keep incentives in place for the purchase of fuel-efficient vehicles.

Incorporating climate change as a key criterion in Oregon Department of Transportation (ODOT) funding decisions would provide an opportunity to give priority to those service improvements and expansions that offer the greatest GHG reductions. Use of the MOBILE 6.2 air quality software could be required as a readily available tool for estimating likely GHG emission results.

The Oregon Road User Fee Task Force is charged with developing a road user fee that will eventually replace the gas tax. While a vehicle miles traveled fee might make sense from a road-user equity perspective, a switch to such a fee might influence consumers to purchase less fuel-efficient vehicles, because the cost impact of different fuel efficiencies (miles per gallon) will be less.

TRAN-6: Expand "Transportation Choices Programs" and "Travel Smart Pilots."

Specific Recommended Actions:

- Expand City of Portland TravelSmart programs. City of Portland programs include environmental and air quality, education, and transportation options.
- Expand CarpoolMatchNW.org statewide and enhance marketing. Encourage the use of ODOT's TripCheck program.
- Provide incentives for investment in station car services (car-sharing link to mass transit). Station service cars would allow access to 'car-share' vehicles at transit stations.
- Using existing transit and social service programs, promote the State's use of additional flexible federal funds to support the efforts of transit providers to coordinate elderly and disabled transportation options.

The Department of Environmental Quality (DEQ) manages the Employee Commute Options program and ODOE provides tax credits and technical assistance to businesses that encourage alternatives to driving alone, such as telecommuting (teleworking). Transportation Management Associations (TMAs) work with major employers to reduce single occupancy vehicle commuting. TMAs assist in coordinating vanpools, carpooling and formation of transit pass programs; these also offer information about transportation demand management options.

TravelSmart is a social marketing program that identifies individuals who *want* to change the way they travel, motivates them to think about their travel options, and provides them with information about how to use transit, bike, walk or carpool for some of their trips.

TRAN-7: Adopt state standards for high efficiency/low rolling resistance tires.

Specific Recommended Actions:

- Use the West Coast states' combined purchasing power to reduce petroleum dependence by obtaining "low-rolling resistance" (LRR) tires for motor pool fleets.

- Ensure state procurement by requiring state fleets to purchase LRR tires; encourage local governments to act consistently with and support state procurement on their behalf.
- Develop a marketing program with tire dealers and consumers to encourage the purchase of LRR tires. This effort might include a voluntary labeling program for tire fuel efficiency.
- Alternate 1: Establish West Coast mandatory labeling requirement by 2010.
- Alternate 2: Establish legislation to set LRR standards for tires by 2010.

Fuel efficiency is directly related to rolling resistance (RR). The greater the RR, the more fuel is burned. The average RR of replacement tires is about 20 percent higher than that of tires that automakers put on new cars. Ecos Consulting estimates the fuel efficiency savings of using LRR tires at 3 percent annually. They estimate a typical driver would save $87 to $260 on fuel at an incremental cost of $9 to $22 for four LRR tires.

The California Legislature passed legislation in 2003 requiring the State to implement by 2008 a replacement tire efficiency program that is designed to ensure that replacement tires sold in the state are at least as energy efficient, on average, as the original equipment.

TRAN-8: Reduce GHG emissions through changes in government fleet purchase and vehicle use.

Specific Recommended Actions:

- Use the West Coat states' combined purchasing power to obtain fuel-efficient vehicles for motor pool fleets; encourage local governments to act consistently with and support state procurement on their behalf.
- Seek a change in the implementation of the federal Energy Policy Act of 1992, which currently excludes hybrid vehicles as an allowable mechanism for compliance with the alternative fuels in state fleets requirement.
- As the fleet turns over, require all state vehicles to be low-GHG and the most efficient in their class.
- Coordinate emission standards for fleet vehicle specifications.
- Develop a model "Green Fleet" Policy Statement that describes policies and/or standards that consider best practices for fleets in a comprehensive way.
- Provide training for fleet managers on how to educate employees about fuel-efficient driving techniques, optimizing vehicle operation and maintenance, and reducing the need to travel.

Public fleets can lead by example in implementing effective purchasing policies and best maintenance practices. The actions above are intended not only to improve pricing and other factors for the three states' purchases, but also to have a positive impact on the market for efficient vehicles and replacement parts.

TRAN-9: State and local governments should switch to "clean diesel" fuel, vehicle purchases and retrofits.

Specific Recommended Actions:

- Support DEQ's efforts to create a buying club for ultra low sulfur diesel fuel, as well as its work to promote diesel engine retrofits to reduce black carbon (soot) emissions.
- Establish a state contract requirement for low-emission fleets and construction equipment.
- Clean up Oregon's school bus fleet by providing funding for replacement of older school buses, retrofit of newer school buses, and purchase of biodiesel fuel. This would have immediate positive impacts on children's health and safety and would result in CO_2 reductions, as well as black carbon emissions. EPA has allocated funds to retrofit school bus fleets under the Clean School Bus USA demonstration program (www.epa.gov/otaq/schoolbus/funding.htm).

DEQ is working to promote voluntary retrofit of diesel engines in both on- and off-highway situations. Users of heavy-duty diesel engines, who retrofit with emission controls, can qualify for a credit against Oregon income taxes of up to 35 percent of the retrofit costs. Retrofits would reduce emissions of black carbon, which contribute to the greenhouse effect.

TRAN-10: Adopt state and local incentives for high efficiency vehicles.

Specific Recommended Actions:

- Pursue legislative approval of a climate-friendly vehicle registration fee (2007).
- Encourage local governments to devise incentive and recognition programs for hybrid owners.

The State could shift the amount drivers pay to title and register their cars in a revenue neutral manner, raising the $55 title transfer fee and $27 per year registration fee for cars with below average MPG (EPA miles per gallon rating) and lowering the fees for more efficient vehicles. This would have mostly a symbolic effect as the increased cost would be about the cost of a fill-up. Raising the fee for less efficient vehicles, but maintaining the fee for more efficient vehicles, could have more impact. In the latter scenario, the additional funds could be used to fix Oregon's bridges and roads.

Local governments could offer revenue neutral incentives such as preferred or free meter parking, recognition decals and other incentives.

TRAN-11: Set and meet goals for reduced truck idling at truck and safety stops.

Specific Recommended Actions:

- Establish a core network of facilities along the West Coast Interstate 5 (I-5) corridor that use techniques to enable truck drivers to rest or "overnight" in their sleeper cabs; this would replace idling their truck engines.
- Support the Oregon Solutions Team on truck idle reduction.
- Support the West Coast Diesel Emissions Reduction Collaborative.
- Institute similar and compatible programs to encourage truck operators to use these facilities as they are established.
- DEQ and ODOE secure federal funding and carbon offset funding for alternatives to engine idling.
- Market existing incentives to support deployment of this technology.
- Increase the number of trucks participating in Oregon's "Green Light" program. Green Light allows trucks to pass over weigh-in-motion (WIM) scales and under transponder readers to pre-clear the weigh station, thus cutting down on idling.
- Review transponder and WIM requirements of Washington and California. Implement consistent equipment requirements along the West Coast.

Supporting the development of infrastructure will reduce diesel truck idling at truck stops and safety stops. Currently, technology exists to outfit truck stops with a custom heating, ventilation and air conditioning system that can be ducted directly to the truck, eliminating the need for idle power. Auxiliary power units are another solution to reduce idling of the main diesel engine.

Truck drivers idle their engines during their rest periods to provide heat or air conditioning for the sleeper compartment, keep the engine warm during cold weather and provide electrical power for their appliances. About 500,000 trucks travel 500 or more miles as their primary range of operation. Based on this travel distance, truck drivers will likely require an extended rest period and may idle their engines during this time. Some studies indicate that the typical duration rest period lasts from six to eight hours per day over 300 days per year.

The West Coast Governor's Global Warming Initiative sets a goal of having the I-5 corridor outfitted with electrified truck stops to reduce truck idling. The governors of Oregon, Washington and California have made this a priority goal for each of their administrations. The goal of this project is to establish a network of truck stop operators and truck fleet managers willing to develop the necessary infrastructure to reduce truck idling in Oregon along the I-5 corridor. This project will lay the groundwork for a core network of facilities to enable truck drivers to use their sleeper cabs and auxiliary appliances without idling.

An Oregon Solutions Team has been convened to implement idle reduction options for Oregon. The goal of the Team is to equip 600 parking spaces at truck stops along I-5 in Oregon with idle reduction technology. This should reduce 24,000 metric tons of CO_2 annually. There are 1,977 commercial truck parking spaces on the Oregon segment of I-5 alone and about 5,000 commercial spaces across the entire State. As the advantages of idle reduction technologies become better known and tested, and as demand grows, the broader goal of the collaborative effort is to install this technology in the majority of truck stops in the State as well as throughout the West Coast. The Team partners include DEQ, ODOE, truck stop owners, Oregon Trucking Association, PacifiCorp, Oregon State University, Oregon Environmental Council and The Climate Trust.

The Oregon project is underway and funding comes from the following key partners:

- EPA is contributing $200,000.
- The Climate Trust will purchase CO_2 offsets for $2 million (plus another $200,000 in Washington).
- The Oregon Business Energy Tax Credit Program (administered through ODOE) will provide $2.3 million in credits.
- The Small-scale Energy Loan Program or SELP (also administered by ODOE) will provide loans for $1.4 Million.
- Technology providers IdleAire and Shurepower have agreed to contribute a portion of overall project costs, if they are selected as equipment providers, as a matching contribution valued at $1.6 million.

TRAN-12: Set up traffic flow engineering "Best Practices."

Specific Recommended Actions:

- Improve signal timing by leveraging The Climate Trust, Federal Highway Administration and City of Portland initiatives.
- Enforce speed limits.
- Apply Intelligent Transportation System solutions.
- Identify, prioritize and reduce recurring traffic congestion and optimize highway speeds to the preferred range.
- Analyze potential projects using value pricing (i.e., congestion pricing).

Truck and auto travel is most energy efficient when vehicles travel in the 40 to 50 mph range without frequent stops and starts. Traffic flow can be optimized through targeted infrastructure investments, traffic signal re-timing, value pricing, and investments in alternatives to the automobile. Projects that improve traffic flow through road widening or traffic management strategies will reduce fuel use in the short-term if vehicles operate at more efficient speeds with less braking and accelerating. However, increasing or improving road capacity may attract more drivers, thereby increasing vehicle miles traveled and eroding GHG benefits.

Intelligent transportation systems encompass a broad range of wireless and wireline communications-based information, control and electronics technologies. When integrated into the transportation system infrastructure and in vehicles themselves, these technologies help monitor and manage traffic flow, reduce congestion, provide alternate routes to travelers, enhance productivity, and save lives, time and money.

TRAN-13: Set and meet goals for freight (truck/rail) transportation efficiency; achieve this through equipment, coordination, and land use.

Specific Recommended Actions:

- Site industrial land/facilities along key freight corridors. Encourage warehouse and distribution center development in existing urban areas.
- Work with ports statewide to adopt "green port" goals and promote state and federal investment in rail/truck/barge mode split.
- Increase rail capacity.
- Support "ConnectOregon."

The State needs to play a larger role in addressing freight rail needs. Improvements for freight rail also would help address conflicts between passenger rail and freight rail needs. Actions include:

- Make strategic investments in multi-modal freight transportation options (e.g., rail, shipping, waterways and any of these in combination with road transport).
- Use Intelligent Transportation Systems (explained in TRAN-12 above) to maximize freight efficiency. Freight railroads move a significant percent of the nation's freight and connect businesses with each other across the country.

"ConnectOregon" is a concept where lottery-backed bonds are used to improve connections between the highway infrastructure and rail, port, transit and marine facilities across the state. Investing in rail and marine transportation systems preserves Oregon's highway investment because commodities that travel via rail and marine tend to be heavy and low volume. If those commodities can be moved by rail or barge, savings will be realized in the increased life-span of the state's highways.

TRAN-14: Establish a consumer awareness education link to transportation choices.

Specific Recommended Actions:

- Use and make available public awareness materials from USEPA/USDOT's It All Adds Up to Cleaner Air program through state and local governments, transportation providers and air quality agencies.

- Participate in the development of the second generation of It All Adds Up to Cleaner Air materials.
- Develop an educational campaign to promote fuel-efficient driving behavior and best practices auto maintenance to be used as part of driver education classes in public schools, Department of Motor Vehicles programs and Vehicle Inspection Program outreach.
- Offer drivers an opportunity to donate to the Climate Trust to offset their CO_2 emissions. Require that car registration materials (or car titling materials) include an educational brochure about fuel-efficient driving.
- Work with car dealers to promote the sale of GHG-efficient vehicles.
- Team up with gas stations to develop an anti-idling campaign, e.g., "Turn your key and be idle free."
- Team up with the automotive service industry to offer "green" auto maintenance options to drivers (e.g., regular maintenance, recycled oil, bio-products, etc.) either in conjunction with maintenance work or oil changes.

Develop an education program to raise public awareness about the connection between global warming and driving. Focus on the benefits of low-GHG vehicles and available incentives for their purchase, as well as ways to boost fuel efficiency through driving techniques and vehicle maintenance.

TRAN-15: Improve mass transit and inter-city transit links.

Specific Recommended Actions:

- The State should make a greater commitment to funding urban transit system expansion and operation as well as inter-city transit links (rail and bus).

Transit can play a key role in reducing GHG emissions and the State should make a greater commitment to funding urban transit system expansion and operation as well as inter-city transit passenger rail and bus. There are many parts of the state in need of better transit systems.

Biological Sequestration Measures to Mitigate Greenhouse Gases

Issue: Carbon dioxide is sequestered (captured and stored) in trees, soils and other biomass. Human activities can release this carbon or increase sequestration.

Solution: To increase sequestration or reduce emissions for forest and other lands, Oregonians need to maintain and increase good land use practices.

TABLE 1 (BIOSEQ)

Refer to Part One, Figure 8 in Section 4 for the cumulative impact of actions.

CATEGORY I: SIGNIFICANT ACTIONS FOR IMMEDIATE STATE ACTION		MMT CO_2E 2025	C/E?
BIOSEQ- 1	Reduce wildfire risk by creating a market for woody biomass from forests.	3.2	Y
BIOSEQ-2	Consider greenhouse gas effects in farm and forest land use decisions.	0.6	Y
BIOSEQ-3	Increase forestation of under-producing lands.	0.5	Y?
CATEGORY II: OTHER IMMEDIATE ACTIONS			
BIOSEQ-4	Expand the application of water-erosion reducing practices for cereal production.	0.2	Y?
BIOSEQ-5	Leverage the Conservation Reserve Program to expand reserved acreage.	0.2	N?
BIOSEQ-6	Establish a municipal street tree restoration program.	less than 0.1	N

In the table above, column three shows estimated CO_2 sequestration in million metric tons (MMT) in 2025. Column four asks if the action is cost-effective (C/E) - yes (Y) or no (N) - to the consumer over the action's lifetime. (This does not address whether it is cost-effective to Oregon and Oregonians broadly, considering the projected effects of global warming and the costs of adapting to those effects.) A question mark means that the estimates of cost-effectiveness are uncertain and more analysis is needed. Because actions interact, CO_2 savings cannot be added. Refer to Figure 8 in Part Two, Section 1 (Introduction to Recommended Actions) for the cumulative impact of actions.

Biomass — Suppression of Wildfires

Background: All plants use energy from the sun's light to make their own food in a process called photosynthesis. During photosynthesis, carbon dioxide absorbed through leaves is broken down by the sun's energy and combined with hydrogen from water to make sugars that plants live on. This process releases oxygen into the air. The carbon in the sugars is stored as biomass in the plant's leaves, branches, trunk, and roots. Plants break down the sugars into energy. This process, called respiration, releases CO_2 back into the air. Plants use much more CO_2 in making their food and storing it as biomass than they release during respiration. The remainder of the carbon is stored in their tissues.[21]

Carbon sequestration performed by plant and soil systems is called biological (or terrestrial) sequestration. Plants and soils fix the CO_2 and store the carbon in living and dead plant tissues and as organic material. Stored carbon can return to the atmosphere as CO_2 when plant biomass or soil organic carbon is oxidized or decomposes through processes such as burning or turning the soil over. When trees are harvested and manufactured into wood products, some carbon remains stored in lumber and other wood products until the wood is discarded and disposed. If it is burned, the stored carbon is released back as CO_2. Wood discarded into landfills continues to store carbon, but may contribute to other greenhouse gases (GHGs) from landfills such as methane.

Much work remains to reduce the risk of high carbon release during catastrophic wildfires. Expanding the amount of forest area that is treated and restored to healthier forest conditions will reduce the risk of extreme fires. It could also provide economic benefits by using hazardous wildfire material as biomass fuel through viable markets for chips and small diameter trees.

In addition, current treatments do not take advantage of small woody biomass that can be used for fuel in energy production, thus displacing fossil fuel CO_2 emissions. The CO_2 savings from increased renewable biomass projects are counted in the GEN-1 action in the Electric Generation and Supply section.

BIOSEQ-1: Reduce wildfire risk by creating a market for woody biomass from forests.

Dense growth has limited the size and resiliency of trees in some forested areas of the state. In the Blue Mountains of Eastern Oregon, for example, the health of large areas of forestland has deteriorated.

The condition of the forest in these overgrown areas is not natural. It is largely the result of fire suppression and past logging practices combined with vegetative expansion due to climate change. Thinning removes dead, suppressed and other competing trees. It improves the health of the remaining trees and changes the behavior of fires. Rather than stand-replacing crown fires that kill larger trees, fires would tend to be less intense, confined to the ground, and would remove under-story brush and small trees.

[21] The Bio-sequestration technical subcommittee of the Governor's Advisory Group did not look at forest management and forest conservation. The successor advisory group will consider incorporating the findings of the West Coast Regional Carbon Sequestration Partnership as it further develops Oregon's strategy to reduce greenhouse gases.

Carefully planned forest thinning activities can preserve wildlife habitat and minimize soil erosion. With less competition for nutrients and water, the remaining trees can grow and increase the amount of carbon stored in standing trees.

However, without a market for forest fuels and small diameter timber, biomass forest thinning is limited by federal and state funds. The alternative of also removing larger, healthy and more valuable trees could offset the cost of thinning, but would not sequester CO_2. There are not enough funds to thin most of the overgrown areas. Development of an economic biomass generation technology could increase the number of acres treated.

An additional 100 MW produced from woody biomass plants would result in the thinning of 2.4 million acres over 30 years. The average annual sequestration from reduced crown fires and improved forest health would be 3.2 million metric tons of CO_2. This CO_2 reduction is in addition to, and does not include, displacing fossil fuels with biomass fuels. The GHG benefit of displaced fossil fuels is included in GEN-1. Additional benefits from this action include rural economic development (1,600 to 2,000 direct jobs), reduced costs of fighting wildfires and avoided smoke pollution.

Viable markets for forest biomass could cover the cost of removing woody biomass from unhealthy forests. The key is to locate smaller biomass-fueled generating plants near forests to reduce hauling costs and to reduce harvest pressure on local forests. Otherwise, the cost of trucking the fuel would outweigh the value of the power generated. Also, diesel trucks emit CO_2, reducing the net reduction of CO_2 from sequestration.

Viable markets will require new smaller generation technologies (2 to 5 MW) and increased state or federal incentives for constructing these small facilities. There are technical and institutional issues with getting power onto the grid from these smaller sized plants. However, smaller plants could improve reliability of the power grid in rural areas.

Most importantly, electric generation using biomass from thinning overstocked stands is now eligible for the federal production tax credit. Previously this tax credit was reserved for wind and closed-loop, energy-dedicated, plantation biomass projects.

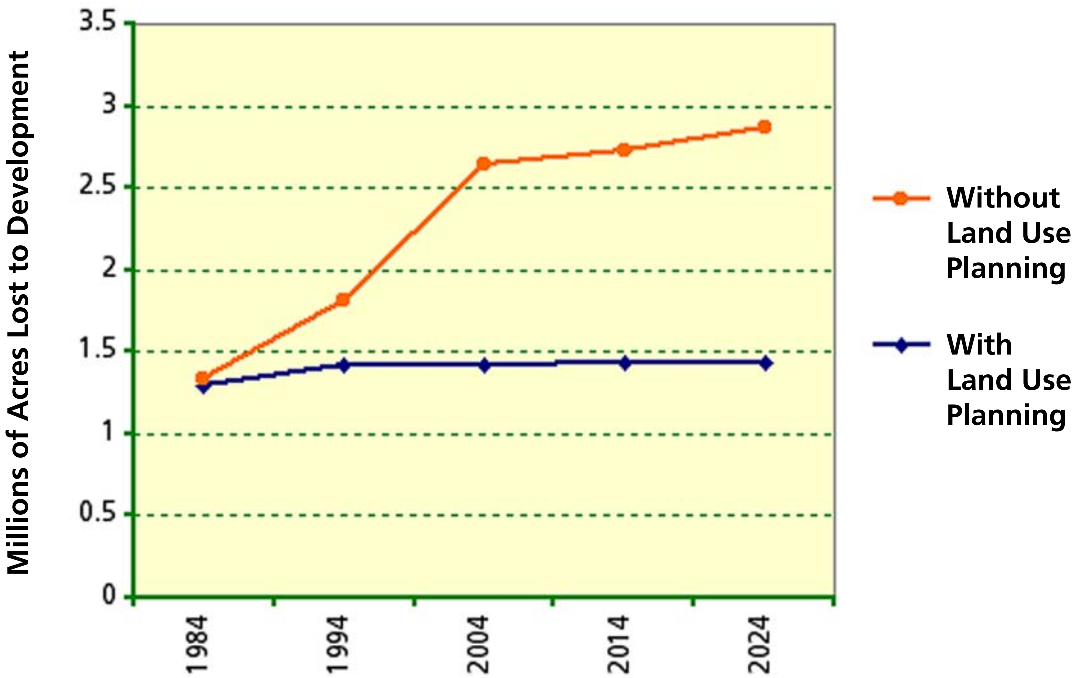
Several possible incentives could supplement the federal production tax credit. Biomass generation is eligible for state energy tax incentives and loans. The Public Utility Commission's Portfolio Advisory Committee could promote environmentally sound woody biomass projects in its mix of green-tag sales to PacifiCorp and Portland General Electric. In addition, the Energy Trust of Oregon might be able to accelerate efforts to use public purpose charge funds for small (under 5 MW) woody biomass projects.

Land Use

Background: Since 1973, Oregon has maintained a statewide program for land-use planning (Oregon Revised Statutes (ORS) 197.010 – ORS 197.245). The foundation of the program is a set of 19 statewide planning goals (Oregon Administrative Rules (OAR) Chapter 660, Division 015 – Statewide Planning Goals and Guidelines, Oregon Department of Land Conservation and Development; **http://www.lcd.state.or.us/goalhtml/goals.html**). Goals 4 and 5, respectively, address maintaining and conserving the forest and agricultural land base. Oregon's statewide goals are achieved through local comprehensive planning for city and county governments. This has led to a system for state-approved local comprehensive plans that cover the entire state.

Trend (Western Oregon): During the period 1974 to the present, urban growth boundaries and land use zoning in local comprehensive plans have prevented the loss of 1.2 million acres of forest and agricultural land to low-density residential or high-density urban development (Figure 1 [BIOSEQ]).

Figure 1 (BIOSEQ)
Trends in Loss of Forests and Agricultural Lands
With and Without Land Use Planning



Adapted from Kline, Jeffrey D. 2004. Estimated forest and farmland conservation effects of Oregon's land use planning program, 1984-2024. [Unpublished]. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Projections through 2024 indicate that local comprehensive plans, if maintained consistent with current statewide planning goals and guidelines, will prevent additional forest and agricultural land conversions to development, though at a slower rate (Figure 1 [BIOSEQ]). Using average carbon stocks of 35 metric tons/acre for forest and agricultural lands and 4.2 metric tons/acre for low-density residential and developed lands (adapted from Delaney 2004), Oregon's land use planning program has prevented 51 $MMTCO_2$ emissions over the 1974-2004 time period or 1.7 $MMTCO_2$ per year.

BIOSEQ-2: Consider greenhouse gas effects in farm and forest land use decisions.

The recommendation is to maintain Oregon's statewide program for land-use planning (ORS 197.010 – ORS 197.245; OAR Chapter 660, Division 015). Carbon dioxide emission reduction benefits from this measure are about 0.6 $MMTCO_2$ per year from avoided emissions by maintaining the forest and agricultural land base.

BIOSEQ-3: Increase forestation of underproducing lands.

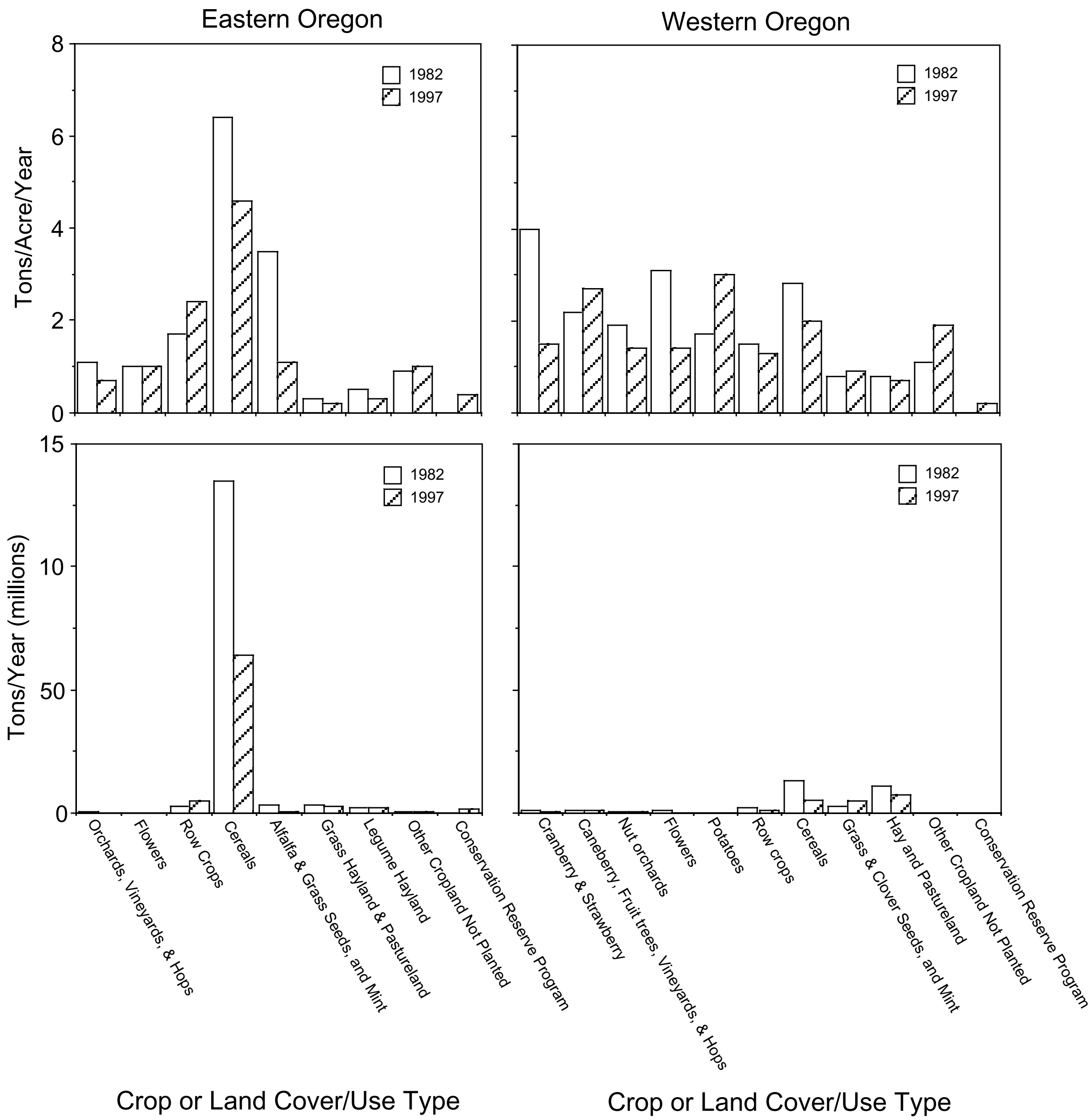
Convert marginal agriculture, pasture and unproductive brush lands (capable of growing forests) back into healthy, productive forests (both riparian and upland). Develop market mechanisms and accompanying carbon accounting mechanisms for the transfer of CO_2 emission offsets from non-federal forest landowners to emitting entities. Continue use of existing state and federal programs (e.g., Oregon's Reforestation of Underproducing Lands 50 percent Tax Credit and the Conservation Reserve Enhancement Program) as a means to provide landowners technical and financial assistance. Increase the current rate of accomplishment by 40 percent.

Carbon dioxide emission reduction benefits from this measure are 0.5 $MMTCO_2$ per year from delayed (beginning in year 2030) permanent carbon sequestration and storage in healthy, productive forests. Additional benefits include expanded timber supply, increased wildlife habitat, improved fish habitat and water quality.

Agriculture and Range

Background: A large proportion of stored carbon in agricultural and rangeland systems is found in the upper soil profile. Factors affecting the amount of stored carbon include the amount of CO_2 sequestered by agricultural crops or range grasses, the amount of biological oxidation of soil organic carbon to CO_2, and the physical loss of soil through erosion. Agricultural and range management practices can affect all three factors. The combined effects can result in a net sink (more CO_2 is sequestered and stored than carbon lost), a net source (more carbon is lost as CO_2 than is stored) or break-even (neither source nor sink).

Figure 2 (BIOSEQ)



Trends in water-erosion soil losses between 1982 and 1987 by crop or land use cover (data from U.S. Department of Agriculture, Natural Resource Conservation Service, National Resources Inventory).

Water-erosion soil loss is used as a surrogate indicator for trends in stored carbon in agricultural systems. Based on site specific capability, agricultural practices such as no tillage, reduced tillage, chemical fallow, and conservation retirement are likely to increase carbon storage over time. These practices reduce erosion and return enough carbon in organic matter to offset the carbon lost to soil oxidation. The amount of precipitation and soil water holding capacity influence the carbon storage ability of rangeland systems. Areas of deep soils and good water holding capacity have more carbon storage potential.

Trend: Between 1982 and 1997, changes in agricultural management practices have generally led to a reduction in water-erosion soil losses for most crop types found in Oregon agriculture (Figure 2 [BIOSEQ]). Most notably, water-erosion soil losses from cereal production systems – by far the single largest source of water-erosion soil loss – have been cut by over 50 percent. Opportunities for enhancing this trend through an expanded application of water-erosion reducing practices are greatest for cereal production systems of the Columbia Plateau. In general, rangeland systems act as carbon storage sinks for most of the year. Through 1997, 486,600 acres of environmentally sensitive cropland have been enrolled in the Conservation Reserve Enhancement program.

BIOSEQ-4: Expand the application of water erosion-reducing practices for cereal production.

Develop new and expand the use of existing incentives for shifting from traditional winter wheat-summer fallow production systems to continuous winter wheat systems for lands capable of this type of system. Where appropriate, incorporate other practices such as reduced tilling. Concentrate efforts in the Columbia-Plateau Major Land Resource Area in Northeast Oregon.

CO_2 emission reduction benefits total about 0.2 MMT per year through avoided emissions and increased sequestration over an 80-year period. Additional benefits are reduced soil erosion and improved water quality.

BIOSEQ-5: Leverage the Conservation Reserve Program (CRP) to expand reserved acreage.

Continue to encourage landowners to convert environmentally sensitive cropland to permanent vegetative cover through the U.S. Department of Agriculture's (USDA) Conservation Reserve Program as administered by the Farm Service Agency. USDA Natural Resource Conservation Service provides technical land eligibility determinations, Environmental Benefit Index Scoring, and conservation planning. Participating farmers receive an annual rental payment over a multi-year contract period. Financing for the Conservation Reserve Program should occur through the federal Commodity Credit Corporation. Developing incentives to maintain existing Conservation Reserve Program acres after existing contracts expire would extend GHG-reducing benefits.

CO_2 emission reduction benefits would be about 0.2 MMT per year through avoided emissions and increased sequestration over a 45-year period. Landowners would be compensated for opportunity costs through annual rental payments. Additional benefits would include reduced soil erosion, improved water quality, improved air quality and increased wildlife habitat. There is potential to put emphasis on restoration of native bunchgrass-sage habitats.

Urban Biomass Sequestration

Background: Urban forests provide many benefits to neighborhoods and communities including the filtering of air pollutants, stormwater runoff control, wildlife habitat, beauty and aesthetics, energy conservation, and carbon sequestration and storage. Urban forests play three important roles in reducing GHGs such as carbon dioxide.

1) Trees connect urban populations to an awareness of the environment and environmental issues such as global warming.
2) Trees provide shade to buildings, so a well-developed urban forest canopy reduces increased temperatures associated with pavement and urban development - both of which lead to reduced energy consumption.
3) Trees sequester and store carbon in the tree biomass.

When calculated solely for their carbon sequestration and storage benefit, renewing and expanding urban forest canopy through tree planting programs appears as a costly strategy due to the high costs of planting and maintenance with relatively modest carbon sequestration benefit. However, the role urban forests play in educating and connecting people with their environment, improved livability in communities and their role in reducing energy consumption are reasons for still including urban tree planting measures as an important part of GHG mitigation.

BIOSEQ-6: Establish a Municipal Street Tree Restoration Program.

Establish a Municipal Street Tree Restoration Program in the Oregon Department of Forestry and administer the program in cooperation with the Oregon Department of Transportation. Funding for the Municipal Street Tree Restoration Account would come by transferring 25 cents from vehicle registration fees collected under ORS 803.420. Funds from the Municipal Street Tree Restoration Account would provide grants to local governments for the purpose of planting street trees within treeless sites along urban street rights-of-ways.

Carbon dioxide emission reduction benefits from this measure are less than 0.1 $MMTCO_2$ per year from delayed (beginning in year 2020) permanent carbon sequestration and storage through increased tree biomass along urban street public rights-of-ways. All registered vehicles in Oregon would pay a fixed share of the cost ($0.25 per registration). This measure has high public education and awareness value due to the explicit connection and direct action on climate change. Additional benefits include reduced storm water runoff, improved neighborhood livability and increased urban forest canopy for wildlife.

Materials Use, Recovery and Waste Disposal Actions for Reducing Greenhouse Gases

Issue: The use of materials by Oregon households and businesses contributes to greenhouse gas (GHG) emissions, primarily carbon dioxide from energy use in the production and transportation of materials, and methane from the decomposition of wastes in landfills.

Solutions: To reduce greenhouse gas emissions, Oregonians can

- decrease the use of materials, particularly those with higher greenhouse gas emissions over their life-cycles;
- increase recycling and composting of certain materials;
- decrease burning of fossil-derived wastes such as plastics;
- reduce the emissions of methane from landfills; and
- recover energy generated during the combustion of wastes and methane at disposal sites.

This discussion evaluates actions relative to a common baseline and independent of other measures. Table 1 (MW) lists the measures that are recommended by the Advisory Group.

Information sources used to evaluate specific measures include waste composition studies, existing policy documents and feasibility studies, reports from evaluation of existing programs in Oregon and elsewhere, and, in some cases, estimates informed by professional judgment.

Table 1 (MW)

CATEGORY I: SIGNIFICANT ACTIONS FOR IMMEDIATE STATE ACTION		MMT CO_2E 2025	C/E?
MW-1	Achieve the waste generation and recycling goals in statute.	5.2	Y
MW-2	DEQ should develop guidance to clarify alternative final cover performance at larger landfills: Demonstrate control of gas emissions comparable to geomembrane cover.	0.53	N
MW-3	Provide incentives for larger landfills to collect and burn a minimum percentage (65 to 80 percent) of methane generated.	@65 percent: 0.47 @80 percent: 0.88	N

CATEGORY II: OTHER IMMEDIATE ACTIONS			
MW-4	Provide incentives to increase salvage of reusable building materials.	0.02	Y
MW-5	Increase the "Bottle Bill" redemption value from 5-cents to 10-cents and expand the "Bottle Bill" to all beverages except milk, including juice, water, liquor, wine, tea and sports drinks; and consider alternative redemption methods.	0.05	?
MW-6	Develop statewide recovery infrastructure for consumer electronics waste, with shared responsibility among producers, retailers, nongovernmental organizations, and government.	0.03	?
MW-7	Change land use rules to allow commercial composting on land zoned High Value EFU (exclusive farm use).	less than 0.01†	Y
MW-8	Increase public awareness to discourage on-site burning of garbage, especially fossil-carbon materials.	0.02	Y
MW-9	Continue landfill regulation with additional reporting and analysis.	Unknown	Y
MW-10	Evaluate methane emissions from closed landfills and options to reduce such emissions.	Unknown	?

In the table above, column three shows estimated CO_2 equivalent savings in million metric tons (MMT) in 2025. Column four asks if the action is cost-effective (C/E) - yes (Y) or no (N) - to the consumer over the action's lifetime. (This does not address whether it is cost-effective to Oregon and Oregonians broadly, considering the projected effects of global warming and the costs of adapting to those effects.) A question mark means that the estimates of cost-effectiveness are uncertain and more analysis is needed. Because measures interact, greenhouse gas reductions cannot be added. Refer to Figure 8 in Part Two, Section 1 (Introduction to Recommended Actions) for the cumulative impact of actions.

†Actual greenhouse gas reductions over time could be several times higher than shown, depending on the measure and the details of implementation. Most of the greenhouse gas benefit of these measures is associated with reducing methane generation at landfills. For the dry landfill that accepts most of the Metro area's waste, methane generation occurs up to 150+ years following disposal, so the majority of emissions offsets occur after the year 2025.

Background

The goal is to identify and evaluate options that could reduce GHG emissions associated with the use and discard of materials by households and businesses in Oregon. Oregon can achieve these GHG reductions by controlling methane emissions from solid waste landfills, reducing the burning of certain wastes, increasing recycling and composting, and using materials more efficiently.

The manner in which materials are used and discarded in Oregon, which contributes to GHGs, is multi-faceted and complex. Some GHG emissions occur inside Oregon, while others occur in other states or even other nations. Some options that reduce emissions lead to an immediate reduction in emissions, while other options may reduce emissions by smaller amounts each year for many years into the future. For a more thorough explanation of the materials life cycle, its GHG emissions, background on waste recovery and disposal in Oregon, and the accounting framework, refer to the document, "Briefing Paper: Materials and Greenhouse Gases," provided as Appendix D.

Projection of GHG Emissions

Waste generation is the sum of recovery plus disposal. According to DEQ, per-capita waste generation in Oregon rose from 5.9 pounds per person per day in 1993 to 7.5 pounds per person per day in 2002. Of this, recovery (recycling, composting and certain types of waste combustion) grew from 1.8 to 3.2 pounds per person per day, while landfilling (disposal) held fairly constant throughout 1993-2002 ranging from 4.1 to 4.5 pounds per person per day.

This historic trend is used as the starting point for projecting future growth in waste generation. To project future per-capita waste generation, we first divided the waste stream into 33 different material categories. These are listed in the addendum to Appendix D. Using DEQ and EPA data, estimates were made of the rate of change in per-capita waste generation during the period 1993 to 2002 for these 33 different categories. These are adjusted to account for changes in reporting and assumptions regarding shifts of waste into the waste system (such as shifting waste from open burning, which isn't counted, to recycling, which is). The accuracy of these estimates is better for some material categories than others. The rates of adjusted growth in per-capita waste generation (by material) were then related to the rate of growth in inflation-adjusted Oregon personal income during the same period, 1993-2002.

The Advisory Group projects that per-capita waste generation, aggregated across all 33 material categories, will grow to 10.1 pounds per person per day in 2025 under the baseline, or a "business as usual" scenario. This assumes relationships between personal income and materials use/waste hold constant. It is based on projections of inflation-adjusted personal income from the Oregon Department of Administrative Services. Coupled with projected population increases, total in-state waste generation (all discards, including recycling and composting) is projected to grow from 5.1 million tons in 2003 to 8.4 million tons in 2025.

Emissions factors over the entire materials life cycle (materials production, transportation and end-of-life management) are applied to these projections of in-state waste generation. Oregon also imports significant quantities of municipal solid waste (garbage) from other states. Waste imports are modeled, growing at a rate of about 4.6 percent per year, from about 1.5 million tons projected in 2003 to 4.0 million tons in 2025. Only emissions associated with the disposal portion of the life cycle are counted for these imported wastes.

For the sake of projections, it is further assumed that:

1. Per-ton emissions factors for materials production, transportation and end-of-life management of each material type (glass, corrugated paper, grass clippings, etc.) remain constant between 2003 and 2025.

2. Open burning of wastes continues to fall.
3. The disposition of all remaining wastes (between recycling, composting, energy recovery, and different landfills) remains fairly constant.

Under these assumptions, GHG emissions are projected to rise from 7.0 million metric tons of CO_2 equivalent ($MMTCO_2E$) in 2003 to 13.6 $MMTCO_2E$ in 2025. This represents almost a doubling of emissions between 2003 and 2025, or an average annual growth rate of about 3.1 percent under the business-as-usual scenario.

Relative Importance of Different Life Cycle Stages
The different life cycle stages (production, recycling, landfilling, etc.) contribute different amounts to the estimate of total net emissions. The relative importance of different life cycle stages varies widely across different types of materials. For example, most of the GHG emissions associated with steel result from energy used during manufacturing, while most of the GHG emissions associated with yard debris occur during landfilling. For the mix of materials and waste as a whole, emissions associated with resource extraction and product manufacturing are, on average, significantly higher than any other category of emissions. Put differently, the majority of emissions occur "upstream" of the user (Oregon household or business). "Downstream" emissions associated with management of discards tend to be smaller, on average, than upstream emissions.

Table 2 (MW) shows the contribution of different life cycle stages to the projected net emissions of 8.9 $MMTCO_2E$ in 2015 associated with the materials life cycle for materials used and discarded in Oregon. These are not included in Appendix B, *Inventory and Forecast of Oregon's Greenhouse Gas Emissions*.

Table 2 (MW)
Oregon Materials Life Cycle, 2015 (Baseline Scenario)

Negative numbers represent offsets. Positive numbers represent net emissions.

Waste generation	**MMTCO$_2$E**
"Upstream" activities of resource extraction, product manufacturing, and transportation	10.92
Recycling	
Material production and transportation	-1.01
Indirect carbon storage in forests	-2.13
Composting	
Production and transportation	0.02
Carbon storage in soils treated with compost	-0.10
Combustion	
Open burning*	0.06
Mass incineration of garbage (Marion, Coos counties)	0.10
Emissions from combustion of other wastes for energy	0.22
Energy recovery offset	-0.58
Landfilling**	
Pre-2003 waste	1.30
Waste 2003-2015	0.04
Total	8.94

** Agricultural and forestry open burning not included*
*** For pre-2003 waste, only methane emissions and energy recovery offsets are included. For waste disposed of in 2003 and subsequent years, the number shown includes methane emissions, energy recovery offsets, transportation/equipment emissions in 2015, and the sizeable carbon storage offsets for materials disposed of in landfills.*

Regulatory Versus Non-Regulatory Approaches

Several measures listed below are characterized as new regulatory requirements. All of the regulatory measures have costs associated with them. However, for some measures, the associated reduction in GHG emissions could be achieved through financial incentives in lieu of regulation. For example, while the State could require all large landfills to capture 65 percent of methane by 2010 through a statutory requirement, the State (or another party) could also provide financial incentives that, by fully or partially offsetting these costs, would achieve the same goal. In some cases, financial incentives (such as grants or tax credits) might be a better option than regulation, especially where the costs and benefits are not well established.

Uncertainty in Evaluating Measures

For the most part, the Advisory Group has relied on EPA emissions factors for the many different types of materials/wastes (steel, aluminum, corrugated, newsprint, etc.) and their different management options (recycling, landfilling, etc.). Some estimates of GHG emissions and savings potential have significant uncertainty and should be considered in that context. Tools, data, and accounting standards for evaluating GHG impacts of the materials life cycle are still relatively new, and substantial research is needed to improve their accuracy.

Several measures vary in their degree of impacts. For example, incentives for landfills to collect 50 percent of generated methane will have a different effect on emissions than an incentive for landfills to collect 80 percent of generated methane; and this will have correspondingly different economic repercussions. Some measures are evaluated at varying levels of intensity or implementation, while others are evaluated at only one level.

The effectiveness of measures also varies over time. For example, the placement of a ton of waste in a solid waste landfill is expected to generate a certain quantity of methane over the period of its decomposition. However, decomposition in "wet" landfills (such as those in Western Oregon) occurs much faster than decomposition in "dry" landfills (including the Columbia Ridge landfill in Arlington, the largest in the state and the repository for most of the Portland area's garbage). Thus, diverting putrescible wastes from landfills in any single year will lead to reductions in actual methane emissions over a period of several decades (in Western Oregon) or even several centuries (in Eastern Oregon). An important corollary to this fact is that programs that divert certain carbonaceous wastes from landfills, even if only for one year, will result in reductions in methane emissions spread over many subsequent years. Therefore, for some measures, the estimates of GHG reductions in the years 2015 and 2025 significantly understate the full quantity of emissions reductions associated with the measure.

The difference between wet and dry landfills also means that waste-related GHG emissions and reduction potentials – both in terms of absolute amounts and timing – vary in different areas of the state.

Projections of methane emissions from solid waste landfills also are uncertain and somewhat controversial because of limited data. A variety of computer models are used to project methane emissions, but the models suffer from some uncertainty and results are dependent on the quality of data inputs and assumptions. Measuring actual methane emissions from landfills is quite difficult.

The GHG reduction impacts of individual measures are also influenced by whether or not additional measures are implemented. Estimates of reductions are not additive when multiple measures are implemented simultaneously. For example, the GHG benefit of food waste composting is a function of many variables including:

- the presence or absence of gas collection and energy recovery at landfills;
- the timing of any changes in gas collection; and
- whether the food is being diverted from a wet or a dry landfill.

Therefore, enhancing methane collection at landfills will reduce the GHG benefit of diverting highly putrescible wastes, such as food, away from those landfills and towards composting sites.

Conversely, achieving the State's waste generation and recovery goals will result in lower emissions from landfills over time, thus decreasing the benefit of enhanced energy recovery systems at those landfills. The cumulative net GHG reduction in 2025 of all of the measures recommended by the Advisory Group for implementation is about 6.0 $MMTCO_2E$.

Finally, it is important to note that all emissions reported below are *net* emissions. In the accounting approach used by the U.S. EPA and the Advisory Group, certain types of activities contribute to offsets, which are counted as negative emissions. Using landfills again as an example, there are four categories of emissions, two of which are offsets (negative emissions):

- CO_2 emissions from equipment used to operate the landfill (positive number)
- methane emissions from the landfill (positive number)
- an offset for landfills that recover energy from landfill gas, which decreases the need to burn fossil fuels elsewhere (negative number)
- an offset for that portion of biogenic carbon that is not expected to decompose in a landfill (negative number). (An example of this would be that portion of dimensional lumber that does not decompose. The EPA has defined a carbon sequestration offset for "carbon storage in landfills.")

Because of this storage offset, a landfill with a moderately effective gas collection system might appear to have zero or even negative *net emissions*. However, ongoing emissions of heat-trapping methane continue and could be further reduced through enhanced gas collection systems.

MW-1: Achieve the waste generation and recycling goals in statute.

ORS 459.015 establishes the following solid waste generation and solid waste recovery goals for Oregon:

Generation:

- By 2005 and in all subsequent years, no increase in per-capita waste generation
- By 2009 and in all subsequent years, no increase in total waste generation

Recovery:

- 45 percent recovery rate in 2005
- 50 percent recovery rate in 2009

These two parallel sets of goals address waste generation (total discards, a rough proxy for material use) and the recovery rate (the fraction of discards diverted from disposal to recycling, composting, and certain energy recovery activities).

The waste generation goals were added to statute by the 2001 Legislature. DEQ and several local governments have a number of pilot projects in various stages of implementation and evaluation.

DEQ is scheduled to develop a waste generation plan during the current biennium. Lacking details on how these goals would be achieved, it is not realistic to evaluate the cost, feasibility, etc. of this measure. Therefore, this measure is evaluated for its GHG reduction potential only, assuming that reductions in waste generation occur across all material types.

Because of significant emissions in manufacturing stages of the life cycle, some materials, such as aluminum, carpet, and electronics, have relatively high per-ton reductions in GHG emissions associated with waste prevention and reuse. Other materials have relatively low per-ton emissions reductions, but are present in such large quantity that significant emissions reductions can still be realized through waste prevention.

Similarly, the GHG benefit of material recovery varies widely across material types (mixed waste paper, film plastics, tires, etc.) and management methods (recycling, composting, combustion with energy recovery). For example, recycling a ton of aluminum reduces net emissions more than recycling a ton of office paper, but there is more office paper disposed of in Oregon than aluminum cans. And while many recovery activities decrease net emissions, a few (such as energy recovery from tires and motor oil) actually *increase* net emissions.

Accomplishing the waste generation goals is projected to result in much greater reductions in GHG emissions (5.0 $MMTCO_2E$) in 2025 than accomplishment of the recovery goals (0.25 $MMTCO_2E$). In part, this is because of how the goals are defined and the fact that Oregon is already very close to achieving the recovery goals, while achieving the generation goals would involve a larger quantity of materials. However, because the two goals are interactive, the combined reduction would be 5.19 $MMTCO_2E$.

In 2002, the State's recovery rate was 46.6 percent. In 2003 it was 47.3 percent. Achieving the recovery goals may require several new initiatives, examples of which are described as subsequent measures below. Therefore, like the waste generation goal, this measure is evaluated for its GHG reduction potential only.

The State of Oregon and all wastesheds in Oregon ("wastesheds" include Metro, all other counties, and one city) have waste recovery goals for 2005 and 2009. Because the waste recovery rates are calculated on a tonnage basis, strategies to achieve the goals have often involved targeting materials that are heavy and/or are disposed of in significant quantities. Some recovery proposals have emphasized the idea of "keeping material out of landfills" without consideration of broader environmental impacts. Increased environmental benefits of waste recovery programs as a whole would result if the following were included in program planning:

- Improved analysis and evaluation tools
- Education of private industry and government staff
- Directives from the Governor's office and/or Legislature to include environmental considerations other than recovery rates (such as GHGs)

It is not known at this time if the waste generation or recovery goals can be achieved without additional regulation and costs, but at a minimum, the Advisory Group recommends that both sets of goals be achieved to the extent that they can be accomplished cost-effectively. Achievement of the recovery goals is highly dependent on strong market demand for recyclables, compostables and energy recovery. Some waste prevention and recovery activities will reduce costs to Oregon households and businesses. Waste prevention may create business opportunities for producers of some materials and services while reducing opportunities for others. Recovery also provides economic development opportunities. There are significant other environmental benefits and potential education and demonstration values associated with achieving these goals as well.

The State should create incentives that will contribute to achievement of the waste generation and recovery goals in a cost-effective manner. "Cost effectiveness" should recognize all costs, including externalities, and quantify them where possible. Achieving the waste generation and recovery goals can reduce GHG emissions and other environmental problems. Incentives should reflect (and monetize, if possible) the environmental and social benefits of achieving the waste generation, recovery and GHG reduction goals.

MW-2: DEQ should develop guidance to clarify alternative final cover performance at larger landfills: Demonstrate control of gas emissions comparable to geo-membrane cover.

Municipal solid waste landfills in wet climates are normally closed with a cover system that includes an impermeable geo-membrane barrier layer to reduce infiltration of precipitation into the landfill. Because methane cannot easily pass through such a cover, geo-membrane barriers have the added advantage of improving the effectiveness of methane collection systems. EPA and state rules allow DEQ's Director to approve "alternative final cover" designs (such as thick layers of soil) as long as these covers are, at a minimum, comparable to the standard design (geo-membrane) at reducing infiltration and controlling erosion. As a practical matter, alternative final covers are only feasible in dry areas east of the Cascades.

Under this measure, DEQ would revise its solid waste guidance for landfills subject to existing EPA New Source Performance Standards for landfill gas (40CFR60 Subpart WWW) so that alternative final covers at such landfills would also need to reduce GHG emissions comparable to a conventional (geo-membrane) cover. Such a guidance change would currently effect only four landfills in Eastern Oregon. No new legislation would be required. The DEQ believes comparable control of gas emissions could likely be achieved by incorporating a gas venting layer and/or compost layer into the alternative cover design, resulting in an estimated reduction of GHG emissions of 0.53 MMTCO$_2$E in 2025. Greenhouse gas reduction benefits would be sustained for decades; much of the methane generation in eastside landfills occurs after individual cells are closed. This would increase landfill costs by about $14 million between 2010 and 2025.

Assuming that the costs are passed back to landfill customers through rates, this would increase garbage costs for users of these four landfills. Users of other large landfills would not see any new rate impacts, as their landfills are already using or planning to use the more protective geo-membrane covers.

MW-3: Provide incentives for larger landfills to collect and burn a minimum percentage (65 to 80 percent) of methane generated.

Under this measure, existing funding incentives would be leveraged, and additional funding would be provided, if necessary, to encourage larger landfills to increase methane collection or other methane controls.

For the purpose of this analysis, we have modeled this measure at two different levels: 65 percent and 80 percent by the year 2010. These percentages were applied to the eight landfills expected to be open in 2010, which are, or are eventually expected to be, subject to existing EPA New Source Performance Standards for landfill gas. Of these, six are privately owned, while the other two are owned by Lane and Deschutes counties. Three of the eight landfills are already at or above 80 percent gas collection rates; two more are estimated at being between 65 percent and 80 percent; two are in the 20 percent to 40 percent range; and the last has minimal gas collection.

Setting a 65 percent collection goal would reduce emissions in 2025 by an estimated 0.47 $MMTCO_2E$, while an 80 percent goal would reduce 2025 emissions by 0.88 $MMTCO_2E$. Achieving the 65 percent goal at all eight landfills would cost about \$3.4 million, while achieving the more ambitious 80 percent goal would cost about \$4.9 million. It is unclear if existing incentives are sufficient to lead to these levels of additional GHG reductions; additional incentives may likely be required. Of course landfills that have already invested in advanced landfill gas collection systems, either because of regulation or on a voluntary basis (to capture energy), would not have as much opportunity to take advantage of this incentive. The incentive is targeted more at landfills that have below-average gas collection systems.

Some landfills with gas collection simply flare the methane, while others have installed energy recovery systems to use the methane to generate heat or electricity. The state Business Energy Tax Credit (BETC) is already available to help incent landfill gas energy recovery systems including collection systems above and beyond those required for compliance with environmental regulations. (Current environmental regulations require landfill gas collection and combustion, but do not address energy recovery. BETC cannot be used if gas is merely collected and flared, the current practice at some landfills.)

Because of the potent GHG impact of methane, which is 23 times as powerful as CO_2, most of the GHG benefit of this measure is associated with gas collection and combustion (converting methane to carbon dioxide), regardless of whether or not energy recovery is included. This alternative would supplement BETC with additional incentives in order to increase gas collection at those landfills with below-average gas capture rates.

Alternatively, the Legislature could establish mandatory methane collection goals for these landfills or direct the DEQ to establish such goals through rule. In this case, compliance would be paid for by customers of those landfills that have below-average gas capture rates. Gas collection rates are defined as gas collection divided by gas generation. One significant challenge is that while gas collection is easily measured, gas generation is not. Normally landfill engineers rely on computer modeling to estimate gas generation. Landfills required to increase their gas collection rate would have the opportunity to demonstrate an alternative gas generation estimate in order to achieve partial or full compliance with the goals.

MW-4: Provide incentives to increase salvage of reusable building materials.

Salvage of reusable building materials, sometimes called "deconstruction" is growing in popularity in Oregon. Some buildings slated for demolition contain valuable furnishings and fixtures, high-value wood flooring, molding and structural lumber, and other materials that can be reused, such as doors and sinks. A growing number of not-for-profit organizations are trying to capture reusable building materials and resell them for reuse.

In this measure, the State would provide incentives, such as grants, to help establish an infrastructure of reusable building materials sites. Presumably, the incentives would primarily support capital and other start-up expenses, as revenue from the re-sale of materials should be sufficient to pay for ongoing operational costs. In addition to environmental and resource benefits, building material salvage provides more affordable materials to middle- and lower-income households. Material salvage programs can also provide living-wage jobs.

At a cost of about $2.3 million between 2010 and 2025, greenhouse gas reductions in 2025 are estimated at 0.016 $MMTCO_2E$.

MW-5: Increase the "Bottle Bill" redemption value from 5 cents to 10 cents and expand the "Bottle Bill" to all beverages except milk, including juice, water, liquor, wine, tea and sports drinks; consider alternative redemption methods.

The deposit and redemption value for beverage containers covered under Oregon's "bottle bill" was established at 5 cents in 1970. Adjusted for inflation, it is worth about 1.6 cents in today's dollars. In recent years, the percentage of containers returned for deposit under the bottle bill has fallen. Further, many beverage containers currently in use are not covered by the bottle bill, because they were not commercially available (or were uncommon) when the bottle bill was established in 1970.

This measure would make at least two changes to the bottle bill. First, it would change the deposit/redemption value of the bottle bill from 5 cents to 10 cents. Second, it would expand the bottle bill to cover a wider variety of beverage containers. As a result, the recycling of these containers would increase. Most of the associated reductions in GHG emissions result from energy savings when post-consumer aluminum, glass and plastic displace the production of virgin resources.

There are other changes to the structure of the bottle bill that might also be proposed, although these have more impact on distribution of costs and responsibilities and political feasibility, and less impact on environmental results. These other issues include:

- allowing redemption to occur at locations other than grocery stores and exempting grocery stores from providing redemption if nearby alternatives are available;
- the formation of an industry-operated container stewardship organization to oversee and operate the redemption system;

- the disbursement of unredeemed deposits (escheats), which are currently maintained by the distributors; and
- the addition of a processing fee to compensate redemption centers for their costs in handling bottle bill materials.

Bottle bill expansion would require statutory change and would face varying levels of political opposition, depending on the nature of the proposed re-design. Higher handling costs associated with processing the additional materials are projected to be roughly $3.5 million annually. GHG reductions in 2025 are estimated to be 0.050 $MMTCO_2E$.

MW-6: Develop statewide recovery infrastructure for consumer electronics waste, with shared responsibility among producers, retailers, non-government organizations and government (reuse and recycling).

Electronic waste ("e-waste"), such as computers, monitors, and televisions, is a rapidly growing waste stream in Oregon and the U.S. Options for end-of-life management of e-waste include disposal, stockpiling, recycling, and reuse. For personal computers (PCs), both reuse and recycling reduce GHG emissions. Because of the large amounts of energy used to manufacture a PC (particularly fabrication of silicon wafers), reuse has much greater GHG benefits than recycling, as long as the reuse displaces or delays the production of a new computer.

Oregon has been a participant in the National Electronics Product Stewardship Initiative (NEPSI), a four-year effort to negotiate a national end-of-life management program for e-waste, where responsibility for managing e-waste is shared between manufacturers, retailers, governments, consumers, non-governmental organizations (NGOs) and businesses. Although agreement has been reached on significant aspects of a national system, manufacturers have yet to agree on an up-front financing approach for the system. Electronics manufacturers held meetings in 2004 to develop a recommendation to bring back to the full NEPSI group for consideration. They were unable to reach agreement. The NEPSI process will produce a final report in early 2005 and various NEPSI stakeholders continue to work on state and national product stewardship solutions. The U.S. Environmental Protection Agency will hold an electronic waste summit in March 2005.

In Oregon the 2003 Legislature passed Senate Bill 867, establishing a statewide Task Force comprised of industry, governments and NGOs, to look at issues related to end-of-life management of e-waste in Oregon. The effort is intended to build upon the concept of product stewardship and the national NEPSI discussions, look at what currently exists and determine what measures would be needed to establish a sound reuse and recovery system for Oregon. The Task Force completed its effort in December 2004. The information gathered by this Task Force will inform any future legislation or efforts in Oregon to manage e-waste at end-of-life. A final Task Force report was published in January 2005.

In addition to the legislation passed in Oregon in 2003, the states of California and Maine have passed landmark legislation in the past year. The California legislation, which will be implemented in 2005, addresses only cathode ray tubes (CRTs) and plasma screens as hazardous waste. It establishes an advance recovery fee on the sale of these devices in order to fund a government-managed recycling program for this specific waste stream. The Maine legislation, passed in the spring of 2004, is a producer responsibility approach requiring manufacturers to be responsible for paying for and providing the transportation and processing of discarded computers, CRTs, television and other computer peripherals through internalization of costs. Government is responsible for setting up the collection infrastructure. Washington also passed a "study bill" similar to Oregon's in the spring of 2004.

The design and funding of a statewide program in Oregon for reusing and recycling e-waste is a complicated issue. For the sake of the Governor's Advisory Group on Global Warming's recommendations, this report assumes a system of shared responsibility, where manufacturers help to pay for and/or operate the infrastructure for reuse and recycling of e-waste, without defining the details of how such a program would operate. Regardless, increasing the recycling and reuse of e-waste would reduce net GHG emissions, with a "middle of the road" estimate of 0.034 $MMTCO_2E$ in 2025. Other benefits include reducing disposal of toxins, increased computer ownership opportunities for lower-income households (via reuse) and potential economic development opportunities.

It is assumed that such a system would require new legislation and that this would require the cooperation of industry, nonprofits and the public sector. Costs of the program depend on its design and scope; at a minimum, collection infrastructure requires financing.

MW-7: Change land use rules to allow commercial composting on land zoned High Value EFU (exclusive farm use).

Composting of food wastes can significantly reduce net GHG emissions, both by reducing methane emissions from landfills and by sequestering carbon in agricultural soils treated with finished compost. However, food waste composting operations, even when operated at high standards, can create odor problems. Because of this, commercial food waste composters are not ideally suited for land zoned as industrial and, as a practical matter, cannot locate near residential or commercial lands without major capital investments (such as mechanical aeration systems with biofilters or totally enclosed composting operations).

Commercial composting that is not in conjunction with farm use is not allowed on lands zoned for high value exclusive farm use (EFU). According to compost industry experts, this makes it very difficult to site a commercial composting operation in most areas of the Willamette Valley, which are zoned high value EFU.

The goal of this measure is to allow for the establishment of composting capacity that is relatively close to waste generators (cities) and is protective of the environment while being affordable. Amending Oregon Administrative Rules (OAR) 660-033-0120 to allow commercial composting as a conditional use on lands zoned High Value EFU would likely allow for the establishment of a few commercial composting operations in the Willamette Valley. Because of high disposal fees for garbage in Marion County and the Metro area, a nearby commercial composter could likely set tip fees high enough to be profitable, yet low enough that larger waste generators could realize financial savings from separating their food wastes from their garbage. In addition to these financial savings to Oregon businesses, expanding food waste composting provides economic development opportunities, GHG benefits and other environmental benefits. The GHG benefits are relatively small in earlier years, but continue for decades due to reduced methane generation at landfills associated with the avoided long-term decomposition of food wastes.

MW-8: Increase public awareness to discourage on-site burning of garbage, especially fossil-carbon materials.

Burning of garbage in burn barrels, burn piles and fireplaces is a source of GHGs and a wide variety of air toxics. It also can create fire risks. GHGs of concern are carbon dioxide from the combustion of fossil-derived materials (plastics, synthetic fabrics, tires, rubber) and nitrous oxide from combustion of paper and wood.

Outdoor burning of plastics, rubber and tires is already illegal in Oregon. Additional restrictions on open burning at both the state (DEQ/EQC) and local (city, fire district) level further limit the outdoor burning of other wastes in some areas. Still, in some areas of the state, significant quantities of wastes are burned.

The State could work with local governments, including fire districts, to further discourage on-site burning of garbage. (The baseline scenario assumes that existing restrictions and enforcement programs remain in place.) This could include education of households and businesses and the development of model ordinance language to make it easier for local governments to adopt burning restrictions.

This measure is easy to implement, except for the additional funding required for coordination and promotion/education, and any local enforcement activities. Reducing burning of wastes has significant public health benefits above and beyond reductions in GHGs. GHG savings are difficult to project due to insufficient data on the quantity and composition of wastes burned, but are estimated to be around 0.02 $MMTCO_2E$ in 2025.

MW-9: Continue landfill regulation with additional reporting and analysis.

Specific Actions:

- Continue to implement Title V regulations for control of methane emissions at landfills and installation of wells in active areas where waste has accumulated for five or more years.
- Require annual reporting of methane generation, collection and collection effectiveness (much of this reporting is already occurring).
- Encourage landfill owners/operators to collect actual data on gas generation.
- Evaluate the accuracy of measurement efforts.

DEQ will continue to require the installation of methane controls at landfills to meet federal and state regulations. Under this measure, DEQ would require additional reporting of estimates of methane generation, collection, and collection system effectiveness at larger landfills.

Collection system effectiveness is defined as gas collection divided by gas generation. One challenge is that while gas collection is easily measured, gas generation is not. Normally landfill engineers rely on computer modeling to estimate gas generation. Under this alternative, DEQ would support landfill operators interested in conducting actual measurements and enhanced modeling of generation.

Ongoing administration of current environmental laws, and compliance with those laws, is assumed as part of the baseline forecast. This measure would result in additional reductions in gas emissions if landfill owners chose to improve further upon gas collection systems in order to maintain competitiveness in a marketplace where potential customers (particularly local governments) might include GHG considerations in their procurement of disposal services.

MW-10: Evaluate methane emissions from closed landfills and options to reduce such emissions.

Oregon is home to many smaller landfills that are now closed and have no or very limited engineered methane controls. The quantity of methane emitted from these landfills is unknown, but was estimated in 2003 to be about half as much as the emissions from the larger open landfills. Emissions from these closed landfills are (on the whole) assumed to be falling, while emissions from larger open landfills continue to climb as waste disposal continues to increase.

Under this measure, the State would evaluate methane emissions from closed landfills and conduct a feasibility and cost-benefit study of methods to reduce emissions, at a cost of about $50,000 to $100,000. Few, if any, of these closed landfills have closure funds available to spend on methane controls, so implementation of any such controls would require additional funding. Statewide costs would potentially be in the millions of dollars, depending on the number of landfills involved and the scope of methane control measures recommended.

State Government Operations Actions to Reduce Greenhouse Gases

Issue: State agencies, through their internal management practices and external program operations or regulatory activities, can add to or reduce Oregon's greenhouse gas (GHG) emissions. Opportunities exist to reduce those GHG emissions and serve as examples for local governments, businesses and other organizations.

Solution: In support of the Advisory Group, state agencies evaluated how they can promote policies and programs that will move Oregon toward GHG reductions. They conducted their review in context of Governor Kulongoski's Executive Order EO 03-03 on sustainability, which he issued in June 2003 and which is also the basis for the Advisory Group's report on reducing GHGs.

The Executive Order and subsequent guidance outlined expectations for 20 state agencies to develop plans that would incorporate sustainability into their management practices. The Governor called for specific actions each agency could take and provided standards and guidelines. Throughout the document, activities were cited as areas of focus for the agencies. These included use of renewable energy, improved water efficiency, expanded materials reduction and recycling, new fleet management opportunities, and alternative fuels use.

While the link to climate change advantages was not a focus of the first Sustainability Plans specified by the Executive Order, the plans typically include GHG reduction activities. Therefore, the Sustainability Plans set in motion a mechanism for moving agencies toward GHG reductions in a united front. All state agencies will be expected to meet GHG reductions proportional to the goals stated in "Recommendation IA-1."

Table 1 (GOV)

GOV-1	State agencies should use their agency Sustainability Plans as the tool for agencies' dynamic involvement in GHG reductions with respect to both their internal operations, and their external program or regulatory activities. Operational and other activities in the areas of electricity, natural gas, land use, transportation, land use, waste and water will be the particular but not exclusive focuses for reductions opportunities. Agencies should approximately calculate and report to the Sustainability Board the greenhouse gas effects of all actions that have potentially significant greenhouse gas emissions consequences: either emissions increases or reductions.
GOV-2	Through a collaborative effort, the Departments of Energy, Environmental Quality and Administrative Services should develop a process to educate agency personnel about opportunities for GHG reductions including how to set goals and calculate GHG reductions.

GOV-1: State agencies should use their agency Sustainability Plans as the tool for agencies' dynamic involvement in greenhouse gas reductions with respect to both their internal operations, and their external program or regulatory activities. Operational and other activities in the areas of electricity, natural gas, land use, transportation, land use, waste and water will be the particular but not exclusive focuses for reductions opportunities. Agencies should approximately calculate and report to the Sustainability Board the greenhouse gas effects of all actions that have potentially significant greenhouse gas emissions consequences: either emissions increases or reductions.

Staff reviewed the agency Sustainability Plans and calculated GHG reductions that agencies might achieve through implementation of the plans. Unfortunately, most of the agency Sustainability Plans did not have activities for which GHG reduction calculations could be made with certainty.

The Sustainability Plan review showed that agencies were knowledgeable about how to move toward sustainability. What was missed in the first round, for purposes of the climate change work, is the link between those selected sustainability activities and GHG reductions and an understanding of the metrics used to calculate those reductions.

The Sustainability Plans are an effective mechanism to move forward the goals of GHG reductions. Table 2 (GOV) shows a summary of those activities where GHG reduction could be calculated. The table does not represent all agencies or all proposed action items. Please refer to www.sustainableoregon.net for a complete list of Sustainability Plans.

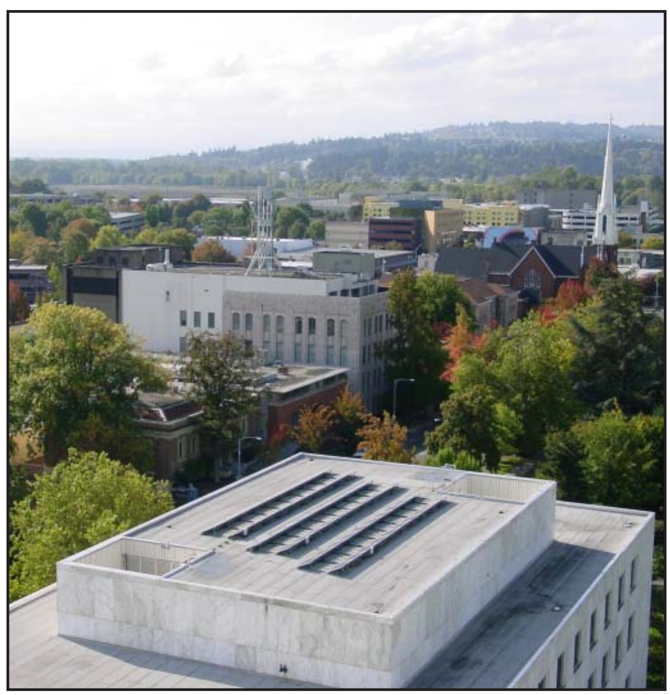


Table 2 (GOV)
Selected GHG Reduction Actions from Agency Sustainability Plans

Agency	Activity	GHG reductions (metric tons)
Energy	Truck stop electrification (with DEQ)	24,000
	High performance school plan	2880
	Train resource conservation managers at state agencies	4
	Technical assistance to agencies	216
	State Energy Efficient Design Program (new state buildings)	997
Housing and Community Service	Energy efficiency and weatherization	4600
Corrections	Solar hot water at Pendleton	1.3
	Geothermal closed loop water system in Lakeview	2800
	Burner controllers on boilers/tuning at various facilities	278
Consumer and Business Services	Extend life of personal computers	170
Administrative Services	Reduce non-renewable energy use by 10 percent below 2000 levels	1500
TOTAL		37,446

Note: This table identifies specific actions that state agencies will take as described in their Sustainability Plans and approved by the Sustainability Board. Not all agencies are listed here and these are not the only activities agencies will take. These are the only actions in the plans where GHG savings could be quantified and forecasted for the purposes of this report.

GOV-2: Through a collaborative effort, the Departments of Energy, Environmental Quality and Administrative Services should develop a process to educate agency personnel about opportunities for GHG reductions including how to set goals and calculate GHG reductions.

As noted, while Sustainability Plans can lead to GHG reductions, many current plans do not address that directly. By providing each agency a simple and uniform record-keeping program for GHG emissions, the agencies will be able to identify and pursue opportunities to reduce emissions.

S E C T I O N 3

Conclusion and Next Steps

Oregon Choices

As Oregonians and Americans, we clearly have choices about how we will respond to the warming of our planet. We can choose a "business as usual" path of contributing ever-increasing greenhouse gas emissions to already high atmospheric concentrations – a path that American and international scientists consider dangerous and alarming. If we choose "business as usual," we leave a legacy for our children and grandchildren of a changing global climate that threatens human habitation and biological ecosystems – with much higher costs required to adapt to and remedy these changes than we will face if we act today.

Alternately, we can adopt the goals recommended in this report and the initial set of actions that will arrest and reverse Oregon's contribution to these atmospheric trends. In doing so, we will set our feet on a path to reduce emissions over time and stabilize the global climate conditions we bequeath to our children. Figure 8, in Part Two above, charts our choices and references potential actions to 1990 emission levels and to our proposed intermediate and long-term goals, although it shows we have not yet proposed actions to achieve the goals fully.

What Scientists Tell Us

Several thousand of the earth's scientists, working together as the Intergovernmental Panel on Climate Change, agree that global warming caused by GHG pollution from human activities represents a profoundly serious threat to human civilization and to even the most robust and insulated natural ecosystems. Their comments are echoed in the *Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest* prepared by scientists at Oregon and Washington universities in the fall of 2004.

Emissions of CO_2 and other GHGs are materially altering the envelope of GHGs that now keep the earth warm enough to be habitable. It's like adding another blanket, and another, until the cumulative effects exceed the capacity of the earth's systems for absorbing the gases and dissipating the heat.

These same scientists can generally describe the effects on the earth of this gathering threat. These effects range from melting glacial formations and rising sea levels, to more severe storms, heat waves, more frequent and more intense forest fires, ecosystem disruptions, species extinctions, and mounting costs to cope with these changes in our world. Already, according to Northwest scientists, we've lost 50 percent of the snowpack in the Cascades since 1950, with global warming identified as the probable cause.

Economic Investments and Opportunities

The economic dimension of dealing with climate change can be stated as a series of "costs," but it can also be stated in a more affirmative way. Many actions proposed in this report carry price tags, but they are generally in the nature of investments that can generate net economic returns to us over time. Most are investments we are experienced in making, from improving the efficiency of our homes, farms, factories and appliances to developing non-polluting new energy sources such as wind, solar, agricultural biomass and other renewable resources. These should remind us of our half century-long investment in hydroelectricity.

Other costs are similar to buying insurance policies against events that would otherwise cost far more to cope with. Avoiding the potentially destructive storms, floods and forest fires that are projected to accompany global warming would likely be less costly than the repairs we would need to make otherwise. These measures will bring the same welcome returns that past investments in flood control have earned.

Moreover, we believe there will be many economic opportunities for companies and communities that rise to the challenge, developing the practices and technology products that our trading partners in other states and countries also will need to cope. We have ample experience in Oregon with this outcome. Many companies here have built prosperous business lines in energy efficiency products and consulting practices, in developing renewable energy technologies, and in adapting the power system for optimal use. We believe Oregon's entrepreneurs, supported by Oregon's academic and technical capabilities, can prosper by positioning themselves at the leading edge of change.

Moreover, taking state action on global warming will position Oregon to trade freely with other countries acting similarly – a group which now includes most of our major trading partners in Asia, Europe and elsewhere. Most of these countries are party to the Kyoto Protocol on Climate Change, which will become effective international law in February 2005 for the countries that have ratified the Protocol.

Principles and Actions

The set of Principles (Section 2.1 in Part One) used to guide our efforts placed primary emphasis on real, measurable and meaningful reductions in the state's GHG emissions. We also emphasized the need to focus first on the most cost-effective actions and those that create investment and entrepreneurial opportunities. We agreed we would not take actions that could impair reliability in our electrical and other energy supply systems, and we believe that many of our recommendations will actually enhance this quality. Our principles create the right direction and focus for Oregon.

We also have proposed a set of actions – some very specific, others more in the nature of changing course – that collectively will meet our first goal of reversing the upward trend of Oregon's GHG emissions. The list of actions we choose or must take over the next fifty years is far from complete, since many needed actions and opportunities will only reveal themselves as we proceed. New, more cost-effective technologies and applications will emerge. Improved scientific understanding will open new doors. Our purpose is to set a firm course on the road to emissions reduction, understanding that our successors will have their turn at the wheel as well. We have assembled a first set of recommended actions to meet our goals and make the most of our opportunities.

Oregon's Role

We recognize that Oregon's contribution to both the problem and its solution is a small part of the whole. We can't succeed without complementary activity on the part of states and nations whose emissions dwarf our own. Fortunately, many countries that have ratified the Kyoto Protocol and other U.S. states are embarking on their responsibilities in parallel with Oregon. So we can anticipate cooperating states – beginning with our neighbors in Washington and California who have joined to form the West Coast Governors' Global Warming Initiative – and competitors as we look for ways to profit from our enterprise. Both should be welcome.

There is a next set of tasks for the Governor's next "advisory group" – further development of some of our more complex recommendations. This new group must also consider what Oregon must do to adapt to the unavoidable warming conditions from GHG emissions that have already accumulated over the past 150 years and that will continue to accumulate for some time.

But first we must decide, as an Advisory Group, a Governor and a state, whether we are prepared to adopt meaningful carbon reduction goals as proposed and to take the actions that will be required to meet those goals.

There couldn't be more of Oregon's future riding on the outcome.

Appendices

Appendix A

Members of the Governor's Advisory Group on Global Warming

Achterman, Gail L.
Gail L. Achterman is the Director of the Institute for Natural Resources at Oregon State University. She received her undergraduate degree from Stanford University in economics and then went to the University of Michigan where she received her J.D. in 1974 and an M.S. in natural resource policy and management in 1975. She started her career working for the Department of the Interior in Washington, D.C. before returning to Oregon in 1978 to join a private law firm. Her law practice emphasized natural resource and environmental law. From 1987-1991 she served as Governor Neil Goldschmidt's Assistant for Natural Resources before returning to private practice. She left Stoel Rives LLP in 2000 to become Executive Director of the Deschutes Resources Conservancy in Central Oregon before joining OSU in 2003 as the first full time director of the Institute.

Allen, Jeff
Jeff Allen became executive director of the Oregon Environmental Council in October 1996, and OEC's membership, budget, and staff have more than doubled during his tenure. He holds a Master's degree in public policy from the University of California, Berkeley, and graduated Phi Beta Kappa from the University of Michigan. His diverse environmental policy experience includes work for the Union of Concerned Scientists, Clean Water Action, the Center for Clean Air Policy, and the California Senate. Jeff is a manic fisherman who also enjoys backpacking, fishing, and wine. He, his wife Martha and son Sam live in Hood River.

Berggren, Randy
Randy L. Berggren has been the General Manager of the Eugene Water & Electric Board since August 30, 1990. He is a professional electrical engineer registered in California. He began his career at EWEB as an Engineering Manager, and was promoted to assistant general manager for planning & development in 1988. Prior to joining EWEB, Jeff held a variety of engineering and administrative positions with the Springfield Utility Board and Southern California Edison Corporation over a 16-year period. He received his bachelor's degree in electronic engineering from the California State Polytechnic University in 1969, and a master's degree in electrical engineering from the University of Southern California in 1971. Randy was a board member for Governor Kitzhaber's Willamette Restoration Initiative and has served as a board member and chairperson on various regional energy associations.

Blosser, Bill
Bill Blosser has worked for 35 years in Oregon as a consultant and public official in land use, environmental and sustainability planning. He founded the sustainable development practice within CH_2MHILL and developed sustainability plans for a variety of clients. He served as

Governor Kulongoski's sustainability advisor in 2002-2003 and led the development of the governor's executive order on sustainability and the guidance document for state agencies to implement the order. He currently serves on the Oregon Sustainability Board and the boards of the International Sustainable Development Foundation, the China-US Center for Sustainable Development, and Sustainable Northwest. As a land use and environmental planner, Bill has participated in developing numerous environmental impact studies, municipal water plans, transportation systems plans, and city comprehensive plans. He served for six years as Chair of the Oregon Water Resources Commission and for 9 years as Chair of the Oregon Land Conservation and Development Commission. He served six months as the Interim Director of the Department of Land Conservation and Development.

Bradbury, Bill
Bill Bradbury grew up in Chicago, and moved to Bandon, Oregon in 1971. In Bandon, he owned and operated a small business before beginning his career in government. He served in the Oregon legislature for 14 years, representing Oregon's South Coast, and went on to direct a local non-profit organization. As Secretary of State, Bill Bradbury is our second-highest-ranking constitutional officer. He is the auditor of public accounts, the chief elections officer, and the manager of the state's official legislative and executive records. Along with the Governor and Treasurer, he sits on the State Land Board, and he was appointed by the Governor to chair the Oregon Sustainability Board. He was elected Secretary of State in 2000, and he now lives in Salem with his wife Katy.

Bragdon, Susan
Susan H. Bragdon (B.A. biology, Williams College; M.Sc. Resource Ecology, University of Michigan; J.D. University of Michigan) uses her educational background and experience in science and law to work on critical global issues such as the conservation, use and management of biological diversity; creating compatibility with environment and agriculture; and promoting food security. She was the lawyer for the Secretariat for the Intergovernmental Negotiating Committee for the Convention on Biological Diversity, providing legal advice to the working group handling intellectual property rights, transfer of technology including biotechnology and access to genetic resources. When the treaty was concluded Susan joined the treaty Secretariat as its Legal Advisor. Susan also served as the top Senior Legal Officer for the Basel Convention on the Control of Transboundary Movement of Hazardous Waste before joining International Plant Genetic Resources Institute as a Senior Scientist, Law & Policy in 1997. She now works on legal and policy issues related to plant genetic resources and in particular manages projects on intellectual property rights, biotechnology and biological diversity and on developing decision-making tools for the development of policy and law to manage access to and benefit-sharing from genetic resource. Susan is invited by governments worldwide to provide advice and give lectures on issues of importance related to the conservation of biological diversity and its links to development.

Burkholder, Rex
Rex Burkholder serves as vice-chair of the Joint Policy Advisory Committee on Transportation (JPACT) and as the council liaison to the JPACT Bi-state Transportation Committee and other regional transportation committees. Rex helped found the Bicycle Transportation Alliance and worked as the policy director for the nonprofit organization, helping to make it one of Oregon's

most active grassroots organizations. He also has taught high school science and served as faculty at Portland State University Office of Student Development. As a community activist for the past 20 years, he was a founding trustee of the nationally recognized Coalition for a Livable Future, which unites more than 50 citizen groups on the issue of sustainability. As a parent-volunteer, Rex helped establish the Northeast Community School, an innovative, diverse charter school in Portland. He has been honored as the 1998 Most Effective Citizen Advocate in the metro region by 1000 Friends of Oregon and as a 1999 founder of a New Northwest by Sustainable Northwest. Rex received a bachelor's degree in biology and a teaching certificate from Portland State University. He earned a master's degree in urban and environmental policy from Tufts University in 1989. He is married, has two sons and enjoys playing tenor guitar, spending time with his family and hiking or kayaking around the Northwest.

Burnett, Michael G.

Michael Burnett is the Executive Director of the Climate Trust. He is an environmental engineer with twenty-seven years of executive, management, policy, and technical experience in climate change, energy efficiency, and renewable resources, mostly in the Pacific Northwest. As the Trust's initial Executive Director, Mike took the organization through its start up phase, overseeing the development of its accounting system and assisting the Board in developing its policies regarding the selection of offsets. He works with the Board on strategic planning for the Trust, oversees the development of annual work plans and budgets, and manages the staff to meet the work plans. Under his guidance, the Trust has assembled a project carbon offset portfolio totaling $5 million and 2.5 million metric tons of carbon dioxide. Mike led the negotiations on the Trust's first five offset projects and put the stamp of his creativity on the term sheets for the current batch of six projects. He is an active participant in the national and international policy debate regarding GHG mitigation.

Mike was a Vice President for Trexler and Associates, Inc., an international leader in climate change mitigation. There, he prepared corporate climate change strategies, developed a climate change early action crediting proposal for a national sustainable technology industry group, and prepared a feasibility study for a major international carbon offset project. Mike was also the founding CEO for Conservation and Renewable Energy System (CARES), a consortium of public power utilities in Washington State. Mike also has worked in energy conservation, renewable energy, and power planning for two utility trade associations, Bonneville Power Administration, the Western Solar Utilization Network, and the National Park Service. Mike earned an M.S. in Environmental Engineering from the University of Florida while on a National Science Foundation Graduate Fellowship.

Dodson, Mark S.

Mark Dodson has served as NW Natural's President and Chief Executive Officer since January of 2003. He joined the company in 1997 as senior vice president and added the general counsel role in 1998. In May of 2001, he was appointed NW Natural's President & Chief Operating Officer. Before coming to NW Natural, Mr. Dodson practiced law for more than 20 years. In 1979, he worked in the General Counsel's office of the Department of Transportation and then became special counsel to the Federal Aviation Administrator in Washington, D.C. After leaving Washington, D.C., he spent 17 years with the law firm of Ater, Wynne, Hewitt, Dodson, Skerritt in Portland, Oregon. His practice focused on regulated industries, international and national transactions and legislative issues. Over the years, Mr. Dodson has been actively involved in a variety of civic activities. He has been chairman of the Oregon State Board of Higher Education, chair of the Neighborhood Partnership Fund, secretary of the Oregon Health Sciences University Board and co-chair of Governor Kitzhaber's Task Force on Scholarship and Student Aid. He also headed the transition of Oregon Governor Neil Goldschmidt. He is currently the chair-elect of the Portland Business Alliance, chair of the Mayor's Business Roundtable and a member of the executive committee of the Associated Oregon Industries. Mr. Dodson grew up in Beaverton, Oregon, and attended Sunset High School. He graduated from Harvard University in 1967 and from Boalt School of Law, University of California at Berkeley in 1973. He is married to Ruth Ann Dodson, and they have two children: Carrie attends Harvard University; and Kevin is a senior at the University of Oregon.

Duncan, Angus

Angus Duncan has served as President and CEO of the Bonneville Environmental Foundation since its formation in 1998. The Foundation generates revenues from regional and national sales of renewable energy and Green Tags. Since 1998, over $1.5 million in Foundation revenues have been dedicated to new renewable energy projects and watershed restoration in the Pacific Northwest. In 1995 Mr. Duncan founded and served as President of The Columbia/Pacific Institute at Portland State University, where he holds an appointment as Adjunct Associate Professor. Mr. Duncan represented three Oregon governors on the Northwest Power Planning Council from 1989 to 1995, including service as Council Chairman (1994-95). Previously he served as Director of Energy Policy, US Department of Transportation. Mr. Duncan has thirty years experience in regional and national energy and environmental affairs, at all levels of government, and in private sector energy development at home and overseas. He speaks and writes frequently on energy and environmental questions, and serves on the Boards of the Oregon Environmental Council and the Northwest Energy Coalition.

Jubitz, Al

A native Oregonian, Al graduated from Beaverton High School in 1962, Yale University (BS) in 1966 and the University of Oregon School of Business (MBA) in 1968. Al married Nancy Thompson of Chestnut Hill, MA and together they have three grown daughters and two grandsons. Al recently retired from the family business (Jubitz Corporation) after a career spanning 34 years. He is Past President of and active in the Rotary Club of Portland and currently serves on the Portland Schools Foundation Board. He is Director Emeritus of Morrison Child and Family Services and a Director of Outward Bound West. He also is engaged in the Jubitz Family Foundation and serves as a director of two private companies. His interests are in the areas of peace, environmental stewardship and early childhood education. He enjoys playing squash and golf.

Leslie, David A.

David Leslie has been executive director of Ecumenical Ministries of Oregon (EMO) since 1997. EMO is a statewide association of 17 Christian denominations including Roman Catholic, Orthodox and Protestant and is one of the nation's largest and longest-lasting regional ecumenical associations. Prior to coming to EMO, David served as Executive Director of Interfaith Ministries for Greater Houston, a coalition of more than 300 congregations and regional and national organizations representing Christian, Muslim, Jewish, Buddhist and Hindu communities. He is a founding member and past president of the National Interfaith Community Ministry Network and was the founding Executive Director of the Habitat for Humanity affiliate in Austin, Texas. Leslie's other professional experiences include the Ohio Council of Churches and World Council of Churches.

Community involvement includes service with Network Behavioral Health Housing Board of Directors, Oregon Department of Human Services (ODHS) Reorganization Stakeholders Group, ODHS Faith-based Advisory Group, Oregon Senate Interim Committee on Farmworker Issues, as well as the Salmon and Economic Development Citizens Forum convened by The Oregon Wheat Growers League and Confederated Tribes of the Umatilla Reservation. Born in San Augustine, Texas, David received his Masters of Divinity from Austin Presbyterian Theological Seminary and his Bachelor of Arts in history from The University of Texas at Austin. He is a lay member of the Presbyterian Church (USA). He is married to Leigh Mohney Leslie, and they have three sons Ian, Ryan and Michael.

Lorenzen, Henry

Henry Lorenzen is a partner in the Pendleton law firm of Corey, Byler, Rew, Lorenzen & Hojem, L.L.P, which he joined in 1984. He has represented numerous utilities and parties acquiring utility system assets, including: the condemnation action by which the City of Hermiston acquired PacifiCorp's electrical distribution system in Hermiston, Oregon; attorney responsible for acquisition of a $45,000,000 electrical distribution system by a newly formed cooperative, Oregon Trail Electric Consumers Cooperative; and serves as General Counsel for Oregon Trail Electric Consumers Cooperative, Baker City, (1988 - present), Umatilla Electric Cooperative, Hermiston, Oregon, (1984 - present), and Columbia Power Cooperative, Monument, Oregon, (1984 - present). Henry is currently retained by the City of Portland for potential condemnation of assets of Portland General Electric.

Henry served as an Assistant United States Attorney (1977-1983). He is Vice President (1973-1990), and President (1990 - present) of H & C Lorenzen Farm, Inc., which is a 4,000 acre family wheat farming operation located near Pendleton, Oregon. He received Umatilla County Conservation Farmer of the Year Award (1992).

Lubchenco, Jane

Dr. Jane Lubchenco is an environmental scientist and marine ecologist who is actively engaged in teaching, research, synthesis and communication of scientific knowledge to interested citizens and policy makers. She received her B.A. from Colorado College, M.S. from the University of Washington and PhD. from Harvard University. She was assistant professor at Harvard University for two years before moving to Oregon State University. She holds two positions at Oregon State University: Wayne and Gladys Valley Professor of Marine Biology and Distinguished Professor of Zoology. Her research interests include biodiversity, climate change, sustainability science and the state of the oceans. She is lead Principal Investigator (of 13 Co-PIs) for a $43 million, 4-university consortium called the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) that is focused on understanding the dynamics of the nearshore portion of the large marine ecosystem along the west coast of the US. She and her husband, marine ecologist Bruce Menge, students and collaborators are also engaged in a comparison of coastal upwelling ecosystems along the coasts of the US West coast, New Zealand, Chile and South Africa.

Jane is the first woman President of the International Council for Science, a Past President of the American Association for the Advancement of Science (AAAS) and of the Ecological Society of America. She serves on the U.S. National Science Board (having been twice nominated by President Clinton and twice confirmed by the US Senate) and she recently completed a term on the Executive committee of the Council of the U.S. National Academy of Sciences. She co-founded and leads the Aldo Leopold Leadership Program and is a Principal of COMPASS, the Communication Partnership for Science and the Sea. Her research contributions in ecology are widely recognized. Eight of her publications have been named Science Citation Classic Papers. She is an elected member of the National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society and the European Academy of Sciences. She serves on the Pew Oceans Commission, an independent group of American leaders conducting a national dialogue on the policies needed to restore and protect the marine ecosystems in US waters. She is a Director or Trustee of the David and Lucile Packard Foundation, the Monterey Bay Aquarium, SeaWeb, the Royal Swedish Academy of Sciences' Beijer Institute for Ecological Economics and Environmental Defense. She has received numerous awards including a MacArthur Fellowship, a Pew Fellowship, eight honorary degrees (including one from Princeton University), the 2002 Heinz Award in the Environment, the 2003 Nierenberg Prize for Science in the Public Interest and the 2004 Distinguished Scientist Award from the American Institute of Biological Sciences.

McArthur, Mike W.

A native Oregonian, Mike McArthur graduated from Lewis and Clark College in 1970 with a BS in Psychology. He played intercollegiate football for fours years and competed on the track team at LC. He then went to Western Oregon to earn a teaching degree and certification with a secondary social science endorsement. Five years of teaching and coaching followed in Portland and the south coast community of Bandon. He married Jeanney, an accomplished multi-media artist, in 1973. In 1977 they left teaching and Bandon to moved to Sherman County, OR to work on a dryland wheat and cattle operation. Mike was elected to and served on the board of directors of the regional grain cooperative: Mid Columbia Producers for six years. He participated in the National Wheat Industry Leaders of Tomorrow program and was County Wheat League president in 1998. They are still involved in the 115 year old family farming operation although not as actively due to Mike's full time job as County Judge, a position to which he was elected in 1992. The county judge in Sherman County is the chair of the board of commissioners and county administrator as well as juvenile and probate judge. In 1999 McArthur served as the President of the Association of Oregon Counties and currently represents Oregon counties on the board of the National Association of Counties. He has held a number of other positions related to community and economic development and now serves in the position of chair of the Rural Affairs Sub-Committee of the Agricultural Steering Committee for NACo. Also, he currently serves on the Governor's Industrial Lands Task force and is Co-Chair of the State Community Development Forum.

MacRitchie, Andrew (alternate for Judi Johansen, PacifiCorp)

Andy MacRitchie became PacifiCorp's executive vice president of Strategy and Major Projects in January 2002. Andy is responsible for strategy, business planning and environmental policy for the U.S. Division of ScottishPower, which includes oversight of the major issues program. He is also a member of the PacifiCorp's Board of Directors. Prior to assuming his current position, Andy formed and served as executive vice president of the Power Delivery business. Here he was responsible for the operational management of PacifiCorp's $4 billion asset base covering electric distribution, transmission and customer service for its 1.5 million customers in Oregon, Utah, Washington, California, Idaho and Wyoming.

Andy moved to the US in December 1998 to lead the ScottishPower merger team through state regulatory commissions' approvals during the company's merger with PacifiCorp. Upon completion of the regulatory process, Andy led the transition planning process, involving a combined PacifiCorp/ScottishPower senior management team in the development of plans to transform PacifiCorp into a top 10 U.S. utility. Andy joined ScottishPower in 1986. Prior to working for ScottishPower, Andy was operations manager at Stagecoach Holdings. He is a member of the Institution of Electrical Engineers (IEE) and is a Chartered Engineer in the U.K. Andy has an honors degree in electronics and electrical engineering as well as an MBA from Strathclyde Graduate Business School in Scotland. He also completed an Executive Development Program at Wharton Business School in the United States.

Mitchell, Ronald B.
Dr. Ronald B. Mitchell is an Associate Professor with tenure in the Department of Political Science at the University of Oregon. He earned his PhD in Public Policy at Harvard University in 1992. He was a Visiting Associate Professor at the center for Environmental Science and Policy at Stanford University from June 1999 through December 2001. He has an award-winning book published with MIT Press as well as numerous articles in scholarly journals. His research focuses on the effectiveness of international institutions at influencing the behavior of states and nonstate actors as well as on the influence of environmental science on international policymaking. He teaches courses on international relations theory, international environmental politics, and international regimes.

Schell, Steve
Steven R. Schell is a partner in the Portland Law Firm of Black, Helterline, LLP. He practices environmental, land use and real estate law. He is a native Oregonian, having graduated from Franklin High School in Portland, the University of Oregon with two degrees, in 1961 a BA in Political Science, and in 1968 a J. D in Law. He has a 1965 M.A. from the University of Denver in Economics. He served in the United States Air Force from 1961 to 1965. He served as a member and vice-chairman of Oregon's Land Conservation and Development Commission from 1973 to 1976, on the Oregon Law Commission task force that resulted in the creation of the Land Use Board of Appeals in 1978-1979, on the State's Energy Facility Siting Council from 1990 to 1998. He currently chairs the Oregon non-profit corporation, Energy Trust of Oregon.

Southworth, Jack
Jack Southworth and his wife, Teresa own and operate Southworth Bros. Ranch, a cow-calf-yearling ranch located on the south side of the Strawberry Mountains near the small town of Seneca. The ranch was homesteaded by Jack's great-grandfather in 1885 and has been operated by his family ever since. He and Teresa graduated from Oregon State University in 1977, married in 1978 and have been operating the ranch since then. Jack is president of the Grant County Farm Bureau, serves as a director of Blue Mountain Hospital, Oregon Agricultural Education Foundation, the E. R. Jackman Foundation and the Blue Mountain Healthcare Foundation. He is an amateur historian and enjoys collecting photos and stories having to do with the history of

southern Grant County. He believes that when ranching is done well, ranchers can produce safe and delicious beef, a healthy ecosystem and do it in a manner that is profitable and enjoyable for the people involved.

Sten, Erik
Over the past 7 years, Portland City Commissioner Erik Sten has led the city's efforts to combat climate change in an urban environment. In 1994, the City of Portland was the first city in the United States to adopt a Local Action Plan on Global Warming. Since then over 400 municipal governments world-wide have followed Portland's lead and adopted climate change mitigation plans. In 2001, Portland City Council and the Multnomah County Board of Commissioners adopted a joint Local Action Plan on Global Warming with a goal of reducing carbon dioxide emissions to 10 percent below 1990 levels by 2010. This target is slightly more aggressive than the 1997 Kyoto Protocol, which, though not ratified by the U.S., set a national reduction goal of seven percent below 1990 levels by 2008 to 2012. Commissioner Sten has conveyed Portland's efforts at many national and international gatherings including a presentation at the United Nations Conference of the Parties on Climate Change in Buenos Aires.

Wilkinson, Jean
Jean Underhill Wilkinson is a partner in Martin Underhill Farms, a family owned wheat and cattle ranch that has existed since 1878. Prior to joining her family business, Jean worked as a lobbyist and legal counsel for the Oregon Cattlemen's Association and the Oregon Farm Bureau Federation. Jean is a current member of the Oregon State Bar, and is Chair Elect for the Agriculture Law Section. She is also President of the Wasco County Wheat Growers Association, and a board member for the Multnomah County Farm Bureau.

Wyatt, Bill
Bill Wyatt has been Executive Director of the Port of Portland since October of 2001. The Port of Portland, governed by a nine member Commission appointed by the Governor, operates four marine terminals, three general aviation airports and Portland International Airport (PDX). The Port has just over 800 employees and annual revenues of approximately $250 million.

Prior to his appointment as the Port's Executive Director, Wyatt served as Chief of Staff to former Oregon Governor John A. Kitzhaber for seven years, preceded by six years as President of the Oregon Business Council, and five years as Executive Director of the Association for Portland Progress, then, Portland's downtown development association. Wyatt served as a state representative from the Astoria area from 1974-1977. He attended public schools in Astoria, and Alexandria, Virginia, and later attended both Willamette University and the University of Oregon, where he was also student body President. Wyatt has been a member of the Board of Directors of Oregon Public Broadcasting, and was Board Chair of the Urban League of Portland. He served as a Director of the Crabbe-Huson mutual funds until their sale to Liberty Mutual in 1998.

Wyse, Duncan
Duncan Wyse became the President of the Oregon Business Council in June 1995. The Oregon Business Council is a private non-profit, non-partisan organization consisting of 46 business executives of some of Oregon's largest businesses. OBC's function is to focus the knowledge and resources of its members on key, long-range public policy issues facing Oregon. Prior to this position, Wyse was Executive Director of the Oregon Progress Board, where he developed

Oregon Shines, Oregon's long-range strategy for economic growth, and *Oregon Benchmarks*, indicators measuring how Oregon is doing as a people, place and economy. Previously, he spent eight years at the California Public Utilities Commission, serving as advisor to the President and Director for Policy and Planning. He was heavily involved in restructuring the telecommunications, electricity and natural gas industries in California. He currently serves on the Oregon Quality Education Commission, the E3: Employers for Education Excellence Board of Directors, the Oregon Mentors Leadership Council, the Multnomah County Leaders Roundtable, Portland-Multnomah Progress Board, the Multnomah County Commission on Children, Families and Community, the Portland Public Schools Foundation, the Willamette Restoration Initiative and the Governor's Global Warming Advisory Group. Wyse holds a Bachelor's degree from Pomona College and a Master's in Business Administration from Stanford University. He grew up in Portland, and is married with three children.

Ex Officio Member

Neilson, Ronald P.

Ronald P. Neilson is a BioClimatologist with the USDA Forest Service, Pacific Northwest Research Station and a Professor (Courtesy) with the Department of Botany and Plant Pathology and the Department of Forest Science at Oregon State University. Dr. Neilson has focused on the theory, mechanisms and simulation of vegetation distribution for nearly three decades. He received the Cooper Award from the Ecological Society of America for his research on oak distribution in the Rocky Mountain region. Dr. Neilson's MAPSS biogeography model and MC1 dynamic general vegetation model have contributed to national and global assessments by the Intergovernmental Panel on Climate Change (IPCC) and the U.S. Global Change Research Program and to *Our Changing Planet*, the formal description of the U.S. Global Change Research Program. Dr. Neilson was the lead author for the Forest sector for the IPCC's special report on *The Regional Impacts of Climate Change* and the convening lead author for an Annex to the Special Report on simulations of global vegetation re-distribution under climate change. His current work extends into Earth System Modeling, Landscape System Modeling and large-scale fire forecasting. Dr. Neilson received the Forest Service Chief's 1999 Honor Award for Superior Science and the USDA Secretary's Honor Award for Superior Service in 2003. He received a BA in 1971 from the University of Oregon, an MS in 1975 from Portland State University, and a Ph.D. in 1981 from the University of Utah.

State Agency Members

Grainey, Michael W.

Michael Grainey is Director of the Oregon Department of Energy in Salem, Oregon. Mike graduated from New York University Law School and received his undergraduate degree from Gonzaga University in Spokane, Washington. He is admitted to practice law in Oregon, Washington and the District of Columbia. His civic activities have included membership on the Board of Directors of the Salem Chamber Orchestra, coaching youth soccer in the Salem Parks and Recreation Program, debate coach for Blanchet High School in Salem and chair of his church's social justice committee.

Hallock, Stephanie
Stephanie Hallock was appointed Director by the Oregon Environmental Quality Commission on Nov 6, 2000. Previous to her appointment she was on a special one-year assignment as a water quality policy adviser for Governor John Kitzhaber's Natural Resources Policy Group. Hallock has been with DEQ since August 1988, serving as Administrator of the Hazardous and Solid Waste Division, Acting Administrator of the Water Quality Division, and Administrator of DEQ's Eastern Region, overseeing agency work in eighteen Oregon counties. She also served at the U.S. Environmental Protection Agency's Region 9 office in San Francisco as chief of the Policy and Grants Branch, and has worked in advertising and public relations at the Hallock/Modey Agency in Portland. Hallock has a master's degree in Public Administration and a Bachelor of Arts degree in English, both from Portland State University.

Savage, John
John Savage has been a Public Utility Commissioner since September, 2003. From January 2002 through August, 2003, he directed the Public Utility Commission's 70-person regulatory staff. From December, 1993 to January 2002, he served as director of the Oregon Department of Energy. During that time, the 1997 Legislature passed the carbon dioxide emissions law for new power plants. From January 1987 to December 1993, John headed the Policy and Planning Division of the Oregon Department of Energy. The Division was responsible for producing the state's energy, global warming, and petroleum contingency plans.

Van't Hof, David
David Van't Hof is the sustainability and renewable energy policy advisor for Governor Kulongoski. Mr. Van't Hof will be implementing the Governor's Executive Order on sustainability, the Governor's three state climate change initiative, and fostering the development of renewable energy and associated technologies in Oregon. He previously served as Governor Kulongoski's natural resources advisor on water, energy and land use issues. Prior to working for the Governor, Mr. Van't Hof was a private sector attorney who focused on natural resources, land use, and administrative law, with an emphasis on major project permitting and water rights. He advised clients on complex regulatory matters such as environmental and siting issues for projects including natural gas, wind, and hydroelectric facilities. He also assisted a variety of public and private clients with National Environmental Policy Act (NEPA), Endangered Species Act (ESA), water rights, and water quality issues and represented several clients in the Klamath Basin Water Rights Adjudication and in contested cases before the Water Resources Department.

Mr. Van't Hof was a former clerk for then Supreme Court Justice Ted Kulongoski. He graduated *cum laude* from the University of Michigan Law School and was Phi Beta Kappa at Trinity College in Hartford, Connecticut. He attended the Institute for European Studies in Vienna, Austria and was a Peace Corps volunteer in Senegal, West Africa. His past professional activities include: member of the Oregon Water Resources Congress, Rocky Mountain Mineral Law Foundation, Oregon State Bar Environmental and Natural Resources Section, Administrative Law Section, and Indian Law Section, Community Water Supply Task Force, organized by the Oregon Water Resources Commission; board member, African Refugee and Immigrant Network of Oregon; founder and former board member and board president, Hands On Portland; volunteer immigration attorney, Sponsors Organized to Assist Refugees; chair of Large Firm Associates Committee, Campaign for Equal Justice.

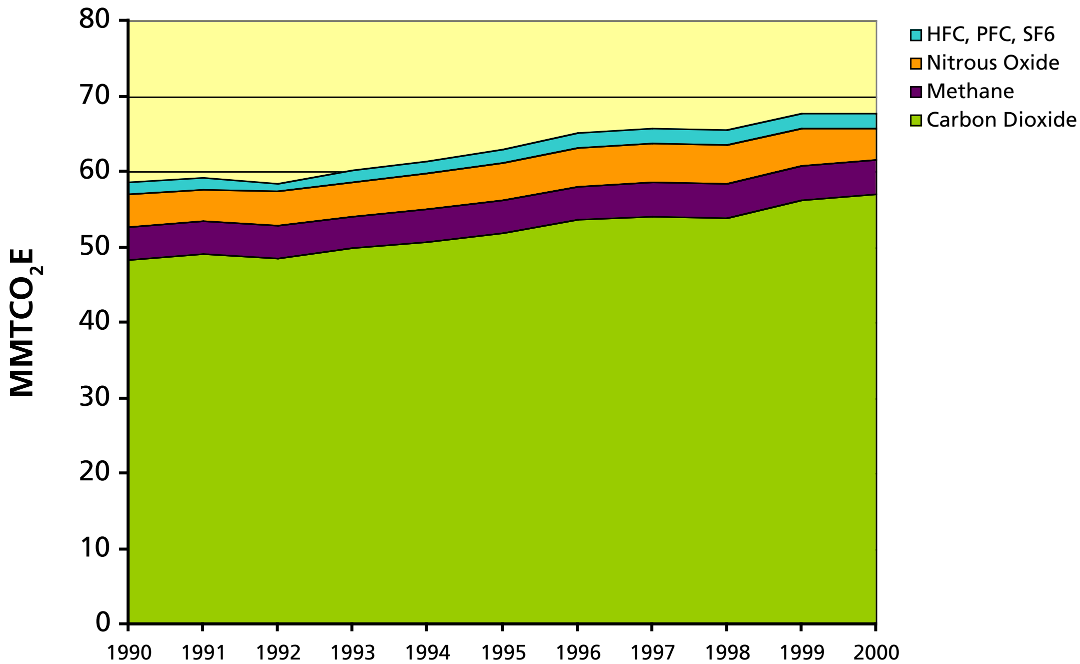
Appendix B

Inventory and Forecast of Oregon's Greenhouse Gas Emissions

In 2000, Oregon's greenhouse gas (GHG) emissions were 67.7 million metric tons of carbon dioxide equivalent[1] (MMTCO_2E).[2] That was about one percent of US GHG emissions, which exceeded 7 billion metric tons CO_2E.

By 2000, there was an 15 percent increase over Oregon's 1990 GHG emissions of 58.7 MMTCO_2E. According to its worst case forecast, the Department of Energy estimates that GHG emissions from Oregon will be 61 percent higher by 2025. Figure 1 shows change in emissions between 1990 and 2000. Table 2 shows historical emissions and Table 3 shows the forecast emissions.

Figure 1
Oregon Greenhouse Gas Emissions



[1] "Carbon dioxide equivalent (CO_2E)" refers to a comparison of the radiative force of different greenhouse gases related to CO_2, based on their global warming potential. It is a way to compare all greenhouse gases on a uniform scale of how much CO_2 would be needed to have the same warming potential as other gases over the same time scale. Following US Environmental Protection Agency (EPA) and international reporting protocols per the Second Assessment Report, methane is 21 times more powerful than CO_2 over 100°years and nitrous oxide is 310 times more powerful for example.

[2] The Department used the US Environmental Protection Agency State Tool for Estimating Greenhouse Gas Emissions to prepare its inventory except for variations in accounting for CO_2 emissions from electricity use, methane emissions from landfills, and a few minor sources. Exceptions are explained in the discussion of gases. EPA's *Emissions Inventory Improvement Program Volume VII: Estimating Greenhouse Gas Emissions* serves as a guide.

Of the GHG emissions from Oregon in 2000, 84 percent came from CO_2. The primary source of CO_2 pollution came from burning fossil fuels, such as coal at power plants serving the state, gasoline, diesel, and natural gas. There were also emissions from industrial processes, such as manufacture of cement and from combustion of fossil-fuel derived products in burning municipal and industrial wastes.

Table 1
Oregon Greenhouse Gas Emissions, $MMTCO_2E$

	1990	1995	2000
Gross CO_2	**49.2**	**52.6**	**57.9**
Net CO_2	**48.4**	**51.9**	**57.0**
CO_2 from Fossil Fuel Combustion	48.5	51.9	57.0
Industrial Processes	0.3	0.3	0.6
Waste	0.3	0.4	0.3
Landfill Carbon Storage	(0.8)	(0.8)	(0.8)
Methane	**4.2**	**4.4**	**4.5**
Stationary Combustion	0.1	0.1	0.1
Mobile Combustion	0.1	0.1	0.1
Natural Gas and Oil Systems	0.6	0.6	0.6
Enteric Fermentation	2.0	2.2	2.2
Manure Management	0.3	0.3	0.3
Waste	1.0	0.9	1.1
Wastewater	0.2	0.2	0.2
Nitrous Oxide	**4.4**	**4.9**	**4.2**
Stationary Combustion	0.1	0.1	0.1
Mobile Combustion	0.6	0.8	0.8
Manure Management	0.1	0.1	0.1
Agricultural Soil Management	3.4	3.8	3.1
Waste	0.0	0.0	0.0
Wastewater	0.1	0.1	0.1
HFC, PFC, and SF_6	**1.7**	**1.8**	**2.0**
Hydrofluorocarbons	0.0	0.3	0.7
Perfluorocarbons	1.1	1.1	0.9
Sulfur Hexafluoride	0.5	0.5	0.3
Gross Emissions	**59.5**	**63.8**	**68.6**
Net Emissions (Sources and Storage)	**58.7**	**63.0**	**67.7**

The inventory includes a reduction in emissions from storage of carbon from yard trimmings, wood products, and other miscellaneous products in landfills. The inventory does not include other land use and forest-management related sources and sinks, such as forest sequestration, because data were not available. They are being collected as part of another study, the West Coast Carbon Sequestration Partnership. Because that effort was already underway when the Advisory Group on Global Warming began, the Department did not attempt to duplicate its efforts.

Table 1 provides a summary of the major sources of greenhouse gas emissions. The individual sources are described in later sections.

In 2000, emissions from methane (CH_4), primarily from cattle and landfills, contributed 7percent of greenhouse gas pollution. Nitrous oxide (N_2O) emissions, primarily from agricultural practices, contributed about 6 percent to greenhouse gas pollution. Manufactured halocarbons, which include hydrofluorocarbons (HFC), perfluorocarbons (PFC), and suflur-hexafluoride (SF_6), accounted for the remaining 3 percent.

Carbon Dioxide Emissions
Fossil fuel combustion is the primary source of CO_2 emissions. Table 2 shows the breakdown of CO_2 emissions from fossil fuel combustion for the majors sectors: electricity generation, transportation, industrial, residential, and commercial.

Table 2
CO_2 Emissions by Sector from Fossil Fuel Combustion, $MMTCO_2$

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Electricity generation	20.7	21.0	20.6	21.4	21.6	22.0	22.7	22.9	21.7	22.9	24.2
Transportation	18.2	18.7	18.5	18.5	19.2	19.4	20.1	20.2	21.2	21.6	21.5
Industrial	5.6	5.6	6.2	6.3	6.3	6.9	6.7	6.9	6.6	7.4	6.8
Residential	2.1	2.2	1.8	2.2	2.1	2.1	2.3	2.3	2.4	2.6	2.6
Commercial	1.9	1.8	1.6	1.7	1.6	1.6	1.8	1.8	1.9	1.9	1.9
TOTAL	**48.5**	**49.3**	**48.8**	**50.1**	**50.8**	**51.9**	**53.6**	**54.1**	**53.8**	**56.3**	**57.0**

Oregon has a Benchmark to hold its CO_2 emissions at 1990 levels. However, between 1990 and 2000 total net CO_2 emissions grew almost 18 percent.

Electricity Generation. Electricity was the major source of CO_2 from fossil fuels in 2000, representing 42 percent of those emissions. Emissions from electricity grew 17 percent from 1990 to 2000, but its relative contribution stayed the same.

The Department calculates emissions from electricity generation based on the carbon content of the regional mix of electricity for the 11 contiguous western states. The Department took the average carbon content from 1990 through 2000 and applied that to electricity loads. While some states inventory only emissions from generating facilities within the state, the Department believes a regional carbon mix better reflects the carbon mix associated with the delivery of electricity to Oregon's consumers.

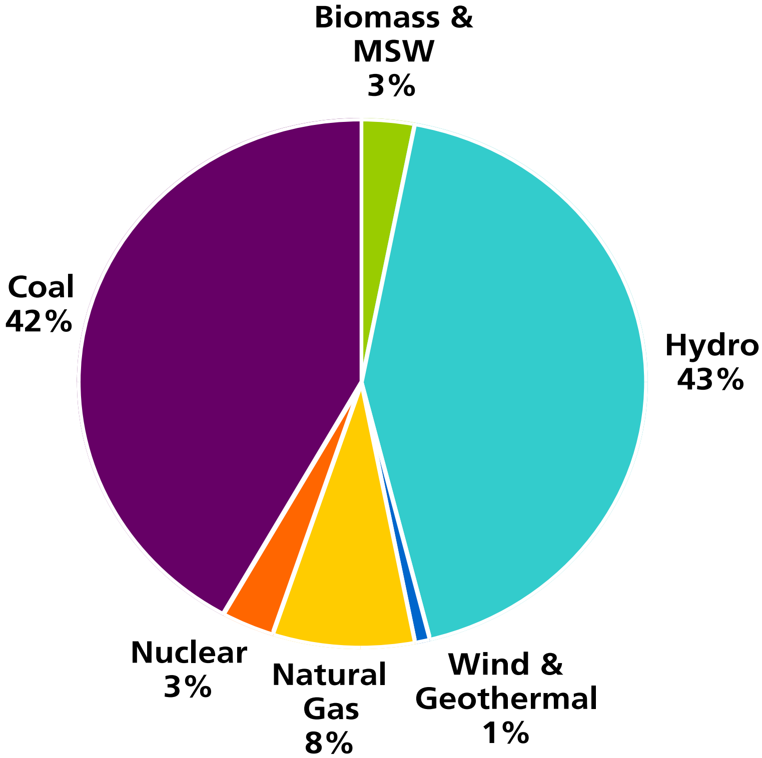
The regional approach better reflects carbon emissions for the following reasons: 1) The regional grid provides electricity to the state. 2) Taking credit for the hydropower generated for the Bonneville Power Administration from dams on the Columbia River, as it is allocated to Oregon in national inventories, does not reflect the way that electricity is distributed in the region. 3) Oregon's second-largest investor-owned utility, PacifiCorp, has most of its generation out of state, and most of that is coal-fired.

Although the comprehensive emissions inventory stops at 2000, the Department does have data from 2002 that reflect the carbon content of the electricity serving the state. This is based on data specific to Oregon utilities, rather than the more general regional average. However, it does not differ significantly from the regional number. Figure 2 shows the sources of electricity that supplied the state in 2002.

The generation mix for 2002 in Figure 2 is based on power plants whose output is dedicated to Oregon utilities. Utilities can generate this output at facilities that they own, either in-state or out-of-state. It also includes cases where a utility purchases the output of a specific power plant. For Portland General Electric, the total of such purchases and ownership is less than its total electric load. In that case, the calculations for the figure assume that the remainder of the electricity is supplied by a mix of resources from the Northwest Power Pool. Utility purchases from the Bonneville Power Administration (BPA) under long term contracts are credited with the BPA resource mix.

The mix of sources shows hydropower, which has no direct emissions, at 43 percent and coal at 42 percent. At 8 percent, natural gas-fired plants were the third largest source of electricity supply. Non-fossil fuel sources also included biomass and municipal solid wastes, shown as one category, and nuclear, which each supplied about 3 percent. Wind and geothermal together supplied only 1 percent.

Figure 2
Electricity Generation Mix Supplying Oregon 2002



Transportation. Gasoline and diesel fuel use in transportation[3] were the second largest sources of emissions from fossil fuels at 38 percent in 2000. Emissions from transportation grew 18 percent from 1990 to 2000, but the relative contribution has not changed.

Direct Natural Gas and Distillate Use. CO_2 emissions from the industrial and residential sector from direct natural gas and distillate fuel combustion grew by 22 and 23 percent, respectively, from 1990 to 2000. Other sources were asphalt and petroleum coke in the industrial sector and liquefied petroleum gas in the residential sector. Emissions from the commercial sector were flat.

Methane

Methane emissions contributed about 4.5 $MMTCO_2E$ in 2000. That represented about 7 percent of Oregon's 2000 greenhouse gas inventory. The distribution of methane emissions for 2000 is shown in figure 3.

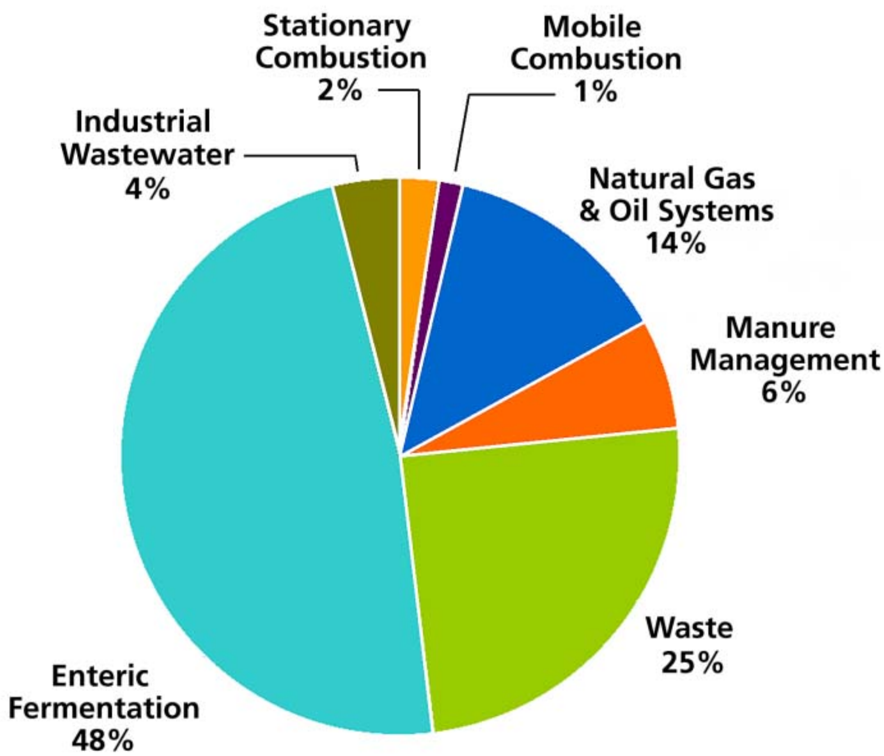
More than half of methane emissions came from agricultural practices. Enteric fermentation, or burps from cattle and other domesticated animals, contributed 48 percent. The methane is generated in the rumen, or first stomach, of cattle and other ruminants. Another 6 percent came

[3] Residual fuels use by vessels is not included because international ships are the primary purchasers. They purchase fuel at any port, based on price. Therefore combustion of the fuel is not directly related to economic activity within Oregon.

from manure management, both from that managed in lagoons on farms or that simply deposited on the ground.

The second largest source of methane was from waste in municipal and industrial landfills at 26 percent.[4] Another 4 percent came from wastewater from pulp and paper production, fruit and vegetable processing, and red meat and poultry processing.

Figure 3
Methane Emissions in Oregon



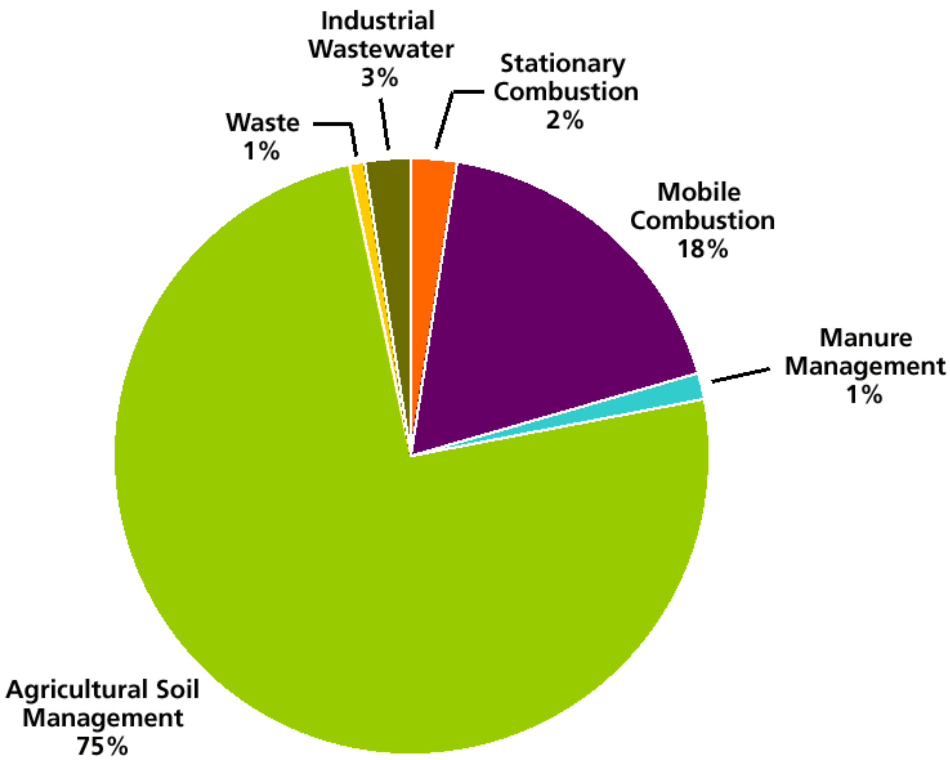
Other sources include leaks from natural gas and oil systems (calculated from miles of pipeline and number of services), emissions from vehicles, and emissions from combustion of natural gas, distillate, residual fuel, and wood in homes and businesses.

Nitrous Oxide
Nitrous oxide (N_2O) emissions contributed about 4.2 $MMTCO_2E$ in 2000. That represented about 6 percent of Oregon's 2000 GHG emissions. The distribution of N_2O emissions for 2000 is shown in figure 4.

4 This represents an estimate of methane actually released to the atmosphere. The amount of methane produced in landfills is significantly higher, but some is converted to CO_2 as it passes through surface soils and some Oregon landfills also capture and flare methane. Since the CO_2 released from landfills is not fossil-based, it is not calculated separately. It is assumed to be recycling through the biosphere.

The primary source of N_2O emissions is from agricultural soil management through numerous pathways. N_2O is emitted from agricultural soils due to synthetic and organic fertilizer use, application of animal wastes through daily spread activities, application of managed animal wastes, crop residues remaining on agricultural fields, biological nitrogen fixation by certain crops, cultivation of highly organic soils, and land application of sewage sludge. N_2O also is emitted from soils from direct deposit of animal wastes in pastures, ranges and paddocks. There are also indirect emissions from fertilizers and from leaching and runoff. In addition to agricultural soils management, N_2O is directly emitted from the manure decomposition process.

Figure 4
Nitrous Oxide Emissions 2000



Small amounts of N_2O are emitted from internal combustion engines and during the catalytic after-treatment of exhaust gases, but these processes are not well understood. In any case, those emissions stayed relatively flat over the period 1990-2000.

Perfluorocarbons (PFCs)
Aluminum production was the major source of PFCs between 1990 to 1996. The emissions occur during the reduction of alumina in the primary smelting process. (As of 2001, aluminum is no longer produced from alumina in Oregon, and recycling aluminum does not produce PFC emissions.)

Beginning in 1997, emissions from PFCs for plasma etching and chemical deposition processes in the semiconductor industry exceeded aluminum production, and by 2000 represented about 70 percent of PFC emissions. However, total emissions of PFCs dropped from 1.2 $MMTCO_2E$ in

1990 to 0.9 $MMTCO_2E$ in 2000. Overall, PFC emissions were about 1 percent of the state's GHG emissions in 2000.

Hydrofluorcarbons (HFCs)
HFCs are most commonly used as a replacement for CFC in cooling and refrigeration systems. (CFC was formerly the most common refrigerant. However, CFC destroys the stratospheric ozone layer. Its production is banned by international treaty.) Use and discharge of HFC is controlled as a refrigerant, but not for other uses.

HFCs are used for foam blowing, fire extinguisher applications, aerosols, sterilization, and as solvents. HFCs are also used in plasma etching and chemical deposition processes in the semiconductor industry. While HFCs do not damage the ozone layer, they are powerful greenhouse gases. HFC emissions rose from nearly zero in 1990 to about 0.7 $MMTCO_2E$ in 2000, when they accounted for about 1 percent of Oregon's GHG emissions.

Sulfur Hexafluoride (SF6)
SF_6 is one of the most powerful greenhouse gases. It is 23,900 times more powerful than CO_2. The largest use of SF_6 is as an electrical insulator in transmission and distribution equipment. SF_6 is also used for plasma etching and chemical vapor deposition processes in the semiconductor industry. There was some SF_6 emitted from aluminum production as well.

SF_6 emissions dropped from 0.5 $MMTCO_2E$ in 1990 to 0.3°$MMTCO_2E$ in 2000, primarily because of declines in emissions from the electricity sector due to better control practices. SF_6 was about 0.5 percent of total GHG emissions in 2000.

Forecasts

The Department forecasts that Oregon's greenhouse gas emissions will grow by 36 $MTCO_2E$, or 61 percent, in the worst case (business-as-usual) estimate from 1990 to 2025. That rate assumes no change from current practices. In reality, it will probably grow less. Table 3 shows the forecast by sources of gases. The following discussion highlights major elements of the forecast.

Electricity and Natural Gas. For CO_2 emissions from electricity and natural gas, the Department used a growth rate of 1.6 percent, which is a composite of Northwest Power and Conservation Council forecasts and forecasts in the integrated resource plans of Portland General Electric, PacifiCorp, and Northwest Natural.

Transportation. For transportation, the 1990 Oregon emissions were 18.3 $MMTCO_2$, according to the Federal Energy Information Administration (EIA) data. By the year 2000, emissions reached 21.5 MMT CO_2, for an annual growth rate of 1.6 percent. Based on the Oregon Department of Transportation's forecast for taxed fuels and U.S. Department of Energy forecasts for jet fuel and freight diesel, the Oregon Department of Energy forecast an annual growth rate of 1.6 percent, leading to emissions of 32.0 MMT CO_2 by the year 2025. The base case transport CO_2 emissions grow 33 percent between 2000 and 2025.

Methane. The forecast for methane emissions from landfills is described in the introduction to the section on materials use in the main report. In summary, the historic trend is used as the starting point for projecting future growth in waste generation. Using Department of Environmental Quality and US EPA data, estimates were made of the rate of change in per-capita waste generation during the period 1993 to 2002 for 30 different categories of wastes. The rates of adjusted growth in per-capita waste generation (by material) were then related to the rate of growth in inflation-adjusted Oregon personal income during the same period.

TABLE 3
Historical and Forecast Oregon Greenhouse Gas Emissions, $MMTCO_2E$

	1990	1995	2000	2015	2025
Gross CO_2	**49.2**	**52.6**	**57.9**	**70.6**	**80.3**
Net CO_2	**48.4**	**51.9**	**57.0**	**69.6**	**79.0**
CO_2 from Fossil Fuel Combustion	48.5	51.9	57.0	69.4	78.8
Industrial Processes	0.3	0.3	0.6	0.9	1.1
Waste	0.3	0.4	0.3	0.3	0.4
Landfill Carbon Storage	(0.8)	(0.8)	(0.8)	(1.0)	(1.2)
Methane	**4.2**	**4.4**	**4.5**	**5.9**	**6.5**
Stationary Combustion	0.1	0.1	0.1	0.1	0.0
Mobile Combustion	0.1	0.1	0.1	0.1	0.0
Natural Gas and Oil Systems	0.6	0.6	0.6	0.7	0.8
Enteric Fermentation	2.0	2.2	2.2	2.6	2.9
Manure Management	0.3	0.3	0.3	0.3	0.3
Waste	1.0	0.9	1.1	1.9	2.3
Wastewater	0.2	0.2	0.2	0.2	0.2
Nitrous Oxide	**4.4**	**4.9**	**4.2**	**5.5**	**6.0**
Stationary Combustion	0.1	0.1	0.1	0.1	0.0
Mobile Combustion	0.6	0.8	0.8	1.0	1.1
Manure Management	0.1	0.1	0.1	0.0	0.0
Agricultural Soil Management	3.4	3.8	3.1	4.3	4.7
Waste	0.0	0.0	0.0	0.0	0.0
Wastewater	0.1	0.1	0.1	0.1	0.2
HFC, PFC, and SF_6	**1.7**	**1.8**	**2.0**	**2.5**	**3.3**
Hydrofluorocarbons	0.0	0.3	0.7	1.9	2.6
Perfluorocarbons	1.1	1.1	0.9	0.5	0.5
Sulfur Hexafluoride	0.5	0.5	0.3	0.2	0.1
Gross Emissions	**59.5**	**63.8**	**68.6**	**84.6**	**96.0**
Net Emissions (Sources and Storage)	**58.7**	**63.0**	**67.7**	**83.6**	**94.8**

The estimate is that per-capita waste generation, aggregated across all 30 material categories, will grow to 10.1 pounds per person per day in 2025 under the "business as usual" scenario. This assumes that relationships between personal income and materials use/waste hold constant and is based on projections of inflation-adjusted personal income from the Oregon Department of Administrative Services. Coupled with projected population increases, total in-state waste generation (all discards, including recycling and composting) is projected to grow from 5.1 million tons in 2003 to 8.4 million tons in 2025. The recovery rate (recycling and composting) of these rates, currently at about 46 percent, is assumed to hold constant, so not all discards end up in landfills.[5]

Oregon also imports significant quantities of municipal solid waste (garbage) from other states. Waste imports are modeled, growing at a rate of about 4.6 percent per year, from about 1.5 million tons projected in 2003 to 4.0 million tons in 2025. Only emissions associated with the disposal portion of the life cycle are counted for these imported wastes.

Other GHG. Most other projection sources are forecast based on linear regressions or exponential regressions of historical data. The Department did not have source-specific forecasts for the many minor contributors. Because most major semiconductor manufacturers have programs to reduce HFC, PFC, and SF_6, we forecast that those emissions from that sector will return to 1995 levels in the future. The 1995 level is therefore the value in the 2015 and 2025 forecast for that sector.

[5] The non-landfill benefits of recycling, composting, and waste prevention, such as reduced fossil fuel use and increased carbon storage in forests and landfills, were included in estimates of the greenhouse gas benefits of specific measures. However, the state inventory does not account for non-landfill offsets, such as savings in industrial processes from using recycled feed-stocks, in part because many of the benefits involve emission reductions outside of Oregon.

Appendix C

Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest

Executive Summary

The signatories of this statement seek to describe the state of scientific knowledge regarding likely impacts of climate change to the Pacific Northwest region. The intent is to assist Governor Kulongoski's Advisory Group on Global Warming in its task of developing a greenhouse gas emission reduction strategy for Oregon. The signatories agree that climate change is underway and that it is having global effects as well as impacts in the Pacific Northwest region. Climate-related changes to date, likely future changes, key questions to answer and research priorities are listed below.

Regional Climate Change Impacts in Recent Decades.
Temperature. Scientists are very certain that the Pacific Northwest is warming and that since 1975 the warming is best explained by human-caused changes in greenhouse gases.
Precipitation. Since the beginning of the 20^{th} century, average annual precipitation has increased across the region by 10% with increases of 30–40% in eastern Washington and northern Idaho.
Sea Level. Land on the central and northern Oregon coast (from Florence to Astoria) is being submerged by rising sea level at an average rate of 0.06 – 0.08 inches (1.5–2 mm) annually, as inferred from data for the period 1930–1995.
Snowpack. Between 1950 and 2000, the April 1 snowpack declined. In the Cascades, the cumulative downward trend in snow-water equivalent is approximately 35% for the period 1950–1995. Timing of the peak snowpack has moved earlier in the year, increasing March streamflows and reducing June streamflows. Snowpack at low-to-mid elevations is the most sensitive to warming temperatures.

Regional Climate Change Projections over the Next 10-50 Years.
Temperature. Scientists have intermediate certainty that average temperatures in the Pacific Northwest will continue to increase in response to global climate change. Assessments suggest that the average warming will be approximately 2.7∀F by 2030 and 5.4∀F. by 2050. These projected increases are highly likely to result in a higher elevation treeline, longer growing seasons, longer fire seasons, earlier animal and plant breeding, longer and more intense allergy season and changes in vegetation zones.
Precipitation. Precipitation changes are very uncertain. The challenge will be to resolve scientific uncertainties about the interactions among atmosphere, land and ocean before significant climate change impacts occur. Oregon is expected to remain a wintertime-dominant precipitation regime (i.e., most precipitation will continue to occur in the winter). In addition, most precipitation will continue to occur in the mountains. Impacts on water resources due to low summer precipitation and earlier peak streamflow will likely include decreased summer water availability, changes in our ability to manage flood damage, shifts in hydropower

production from summer to winter, and decreased water quality due to higher temperatures, increased salinity and pollutant concentration.

Sea Level. Sea level is very certain to continue to rise although the impact will vary depending upon how fast the land is rising. In addition to increases in sea level, maximum wave heights will likely also increase, resulting in increasing erosion in coastal areas.

Snowpack. The April 1 snowpack will continue to decline corresponding to an earlier peak streamflow.

Marine Ecosystems. It is very certain that ocean circulation will continue to change in response to ocean-atmospheric processes. These changes suggest a likely increase in the magnitude and duration of upwelling, which will affect marine ecosystems. It is uncertain whether these changes will have adverse impacts such as more frequent occurrences of the low-oxygen ("dead zone") events seen in 2002 and 2004.

Terrestrial Ecosystems. The impact of changes in temperature and precipitation on terrestrial ecosystems is poorly known. Due to current biomass densities, the anticipated drier summers will likely increase drought stress and vulnerability of forests to insects, disease and fire.

Important Questions that could be Answered by Research.

What will be the trend and pattern of precipitation in the region?
What will be the patterns of coastal ocean winds?
What are the dynamics of large, decadal-scale patterns of ocean/atmosphere interactions?
Do thresholds exist for abrupt climate change and system shifts?
How will these patterns affect ecosystem patterns and resilience?
How will changes impact human health?
How will changes affect regional economic and social conditions?

Research Priorities

1. Improved and sustained observation of critical processes that can resolve interannual/decadal-scale variability.
2. Focused process experiments and studies of critical processes, such as impacts of increased CO_2 on forest dynamics.
3. Improved numerical and statistical models focused on coupled atmosphere/ocean/land processes that include ecological as well as geophysical dynamics.
4. Modeling and analysis of the effects of economics and management policies interannual/decadal-scale processes in the region.

Scientific Consensus Statement on the
Likely Impacts of Climate Change on the Pacific Northwest

History and Objective

This Consensus Statement was drafted by a subcommittee of participants in the scientific meeting "Impacts of Climate Change on the Pacific Northwest" convened at OSU on June 15, 2004. The statement has been reviewed and signed by 50 meeting participants. The objective of the statement is to assist Governor Kulongoski's Advisory Group on Global Warming (GAGGW) by describing the state of scientific knowledge and uncertainty regarding climate change impacts in the Pacific Northwest. The GAGGW is charged with recommending strategies for reduction of greenhouse gas emission for the State of Oregon. For more information about the consensus process and participants, see Appendix A.

Global Effects of Climate Change

The signatories of this consensus statement agree with the scientific findings about climate change as reported in the Third Assessment Report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC), published in 2001. The IPCC finds that

- over the last century, the global average surface temperature increased about 1∀F, and
- sea level rose between 4 and 8 inches.

The IPCC predicts that if current trends continue, by 2100

- the global average temperature will increase 2.5–10.4∀F and
- sea level will rise 4–35".

The IPCC report concludes that

> "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

An overview of these and other findings from the IPCC Third Assessment Report is attached in Appendix B.

Regional Impacts of Climate Change

Climate change is also affecting important parameters and processes on a regional scale. This Consensus Statement addresses the following key questions related to the impacts of climate change on the Pacific Northwest:

- What are the areas of consensus on the impacts of climate change on the Pacific Northwest based on scientific findings and observed changes?
- What are the projections for impacts of climate change on the Pacific Northwest over the next 10–50 years?
- What are the areas of uncertainty affecting our ability to understand and predict likely climate change?
- What are the most important questions to be answered in the next 5–10 years?
- What are the priorities for future research?

What are the areas of consensus on the impacts of climate change on the Pacific Northwest, based on scientific findings and observed changes?
Some major parameters and processes in the Pacific Northwest affected by climate change are described below. Areas of consensus on these topics, based on scientific findings and observed changes, were gathered and synthesized from a variety of sources, including the U.S. Global Change Research Program Report (USGCRP 2001), papers in peer-reviewed scientific publications, and scientific presentations and breakout group summaries from the June 2004 Impacts of Climate Change in the Pacific Northwest meeting at OSU.

Temperature
Scientists are very certain that the Pacific Northwest is warming. The USGCRP Report indicates that the annual average temperature has increased 1–3° F (0.6–1.7° C) over most of the region in the last century. Temperature change during this time is characterized by a steep rise from 1900 to 1940, a decline from 1940 to 1975, and a rise thereafter. Model simulations suggest that the earlier warming was largely due to natural causes, whereas the most recent warming is best explained by human-caused changes in greenhouse gases (Water Resources Breakout Group 2004). Since 1920, nearly every temperature monitoring station in the Pacific Northwest—both urban and rural—shows a warming trend (Mote 2003).

Precipitation
While there is little evidence of a consistent global warming signal for precipitation in the West since 1915, precipitation has increased modestly from 1916 to 1997 (Water Resources Breakout Group 2004). Since the beginning of the 20^{th} century, the USGCRP Report indicates that annual precipitation has increased across the region by 10% on average, and the level of increase has reached 30–40% in eastern Washington and Northern Idaho.

Sea Level
During the period 1930–1995, land on the southern Oregon coast between Florence and Coos Bay has generally risen faster than worldwide changes in sea level by about 1 mm per year (Abbott 2004). However, the same data, which are based on geodetic leveling and tide-gauge records, indicate that land on the central and northern coast of Oregon (from Florence to Astoria) is being submerged by rising sea level at a rate of 1.5–2 mm per year.

Snowpack
From 1950 to 2000, warming temperatures across the West have diminished snowpacks. During this period, most monitoring stations in the Pacific Northwest show a decline in April 1 snowpack (or "snow water equivalent") (Miles 2004). In the Cascades, the cumulative downward trend in snow water equivalent is approximately 35%. Model simulations for the period 1950–1995 show that roughly half the reductions in the Cascades are due to warming trends, and half are due to downward trends in precipitation. Trends for the period 1916–1995 show smaller trends due to warming (a 20% decrease in 82 years) and little effect from precipitation (Water Resources Breakout Group 2004).

Simulations of snow-water equivalent from 1916–1997 show that the timing of peak snow accumulation and 90% snowmelt have both moved toward earlier calendar dates across the West (Water Resources Breakout Group 2004; Miles 2004). In sensitive areas like the Cascade, for example, the date of peak snowpack has shifted by as much as 40 days earlier in the year. These simulations are supported by studies of observed snowpack, along with observations of stream flow from 1950–2003 which show systematic reductions in April 1 snowpack and June flow, and increases in March flow, over much of the West (Water Resources Breakout Group 2004; Stewart et al. in review).

Snowpack at low-to-mid elevations is the most sensitive to warming temperatures. Watersheds in the Cascades have shown significant losses of summer water availability due to warming over the last 55 years. The fraction of annual streamflow from May to September in the Cedar River watershed, for example, has declined by 30% in 55 years (Miles 2004). These observed changes in streamflow are not explained by trends in precipitation.

Climate Variability at the Scale of Years to Decades

The USGCRP Report indicates that the climate of the Pacific Northwest shows significant recurrent patterns of year-to-year variability. Warm years tend to be relatively dry with low streamflow and light snowpack, which lead to summer water shortages, less abundant salmon, and increased probability of forest fires. Conversely, cool years tend to be relatively wet with high streamflow and heavy snowpack. Scientists conclude with high certainty that variations in Pacific Northwest climate show clear correlations with the large-scale ocean-atmosphere patterns associated with the El Nino/Southern Oscillation (ENSO) on scales of a few years (interannual) (Abbott 2004). Because of uncertainty about underlying dynamics and lack of predictability about other large-scale ocean-atmosphere patterns, such as the Pacific Decadal Oscillation (PDO), understanding the effects of such patterns on climate variability in the Pacific Northwest is problematic at present.

What are the projections for climate change and its impacts in the Pacific Northwest over the next 10-50 years?

Temperature

There is intermediate certainty that average temperatures in the Pacific Northwest will continue to increase in response to global climate change. The slope of the trend over the last 20 years should continue in the next few decades. The USGCRP Pacific Northwest assessment predicts that there will be average warming over the region of approximately 2.7° F (1.5° C) by 2030 and 5.4° F (3° C) by the 2050s. This change translates into a 0.18 to 0.9° F (0.1–0.5° C) increase per decade. However, the rate of increase may be even higher in the eastern portion of the region. The exact magnitude and rate of increase are difficult to predict, particularly beyond 50 years.

These projected temperature increases are highly likely to result in:

- An increase in elevation of the upper tree line,
- Longer growing seasons,
- Increased length of fire season,
- Earlier breeding by animals and plants,
- Longer and more intense allergy season, and
- Possible changes in vegetation zones.

Other changes, such as prevalence of insect infestations and expansion of woody vegetation, are less certain (Terrestrial Ecosystems Breakout Group 2004), in part because they are affected by additional factors such as precipitation and land use.

Precipitation
Changes in precipitation regimes are generally acknowledged to be very uncertain in comparison with the temperature changes described above. Existing models are unable to make consistent projections of precipitation on regional scales. Recent IPCC global climate model scenarios have suggested the likelihood of modest increases in winter precipitation and decreases in summer precipitation for the Pacific Northwest. These effects are broadly consistent with the expected consequences of an intensified hydrologic cycle at the global level.

Some current research, however, suggests that these scenarios could be wrong for the Pacific Northwest because other factors may influence the outcome. For example, systematic changes in global sea surface temperature patterns, or in other fundamental drivers of global atmospheric circulation, could create systematic changes in storm-track behavior (Water Resources Breakout Group 2004). Based on this hypothesis, the Pacific Northwest could conceivably become drier, despite an intensification of the hydrologic cycle on a global level. These alternate hypotheses underscore the current uncertainty even about the direction of trends (i.e., increasing or decreasing) in precipitation. Better understanding of the interactions among atmosphere, land, and ocean are critical to predicting changes to and patterns of precipitation. The challenge will be to resolve these scientific uncertainties before significant climate change impacts occur.

Regarding specific projections, Oregon now experiences most of its precipitation during winter, with the greatest precipitation occurring in the mountains. The expectation is that this pattern will continue, and that the greatest precipitation (in the form of snow) will remain at high elevations. Changes in cool-season (i.e., October–March) climate are, therefore, likely to have the greatest effect on river flow and water resources.

Due to relatively little precipitation in summer and an earlier summer streamflow recession associated with earlier snowmelt, intensified impacts on water resources likely will include:

- Increased summer water demand (because of population growth) coupled with decreased water availability due to warmer temperatures, systematic reductions in summer streamflow, and limited reservoir storage.

- Changed ability to mitigate flood damage (which could result from increased unpredictability associated with extreme weather events and streamflow forecasting) that may warrant reconsideration of current management schemes for storage reservoirs and flood protection to account for this altered flow regime.

- Increased winter flows (if precipitation remains the same or increases in winter) that enhancement hydropower production in winter months and reductions in summer streamflow that diminish hydropower production in summer months may challenge the current approach to hydropower production in the Columbia River (Water Resources Breakout Group 2004).

- Decreased summer water availability and late-summer flows that may further decrease the overall ability water of water regulators and users to meet instream flow targets using storage reservoirs, and intensify the conflict between winter hydropower production and summer water supply.

- Exacerbated water-quality issues, including increased water temperatures in lakes and rivers, increased salinity and pollutant concentration (because water withdrawals decrease water quantity and concentrate pollutants in remaining water), lower dissolved oxygen content with increasing temperature, increases in certain pathogens that thrive at higher temperatures, and changes in the ecosystem and food web—all of which would stress fish including salmon.

Sea Level
Sea level is very certain to continue to rise. The impacts of sea-level rise, however, will vary because of differences in tectonic processes throughout the Pacific Northwest. In some areas where tectonic processes exceed sea-level rise, land will rise faster than increased sea level. Where tectonic processes do not exceed sea-level rise, the region's shoreline will move landward. Maximum wave heights also will likely increase. This increase in wave height, in association with sea-level rise, has the potential to increase erosion in coastal areas.

Snowpack
It is highly certain that the April 1 snowpack will continue to decline in response to increasing global greenhouse-gas emissions. This decline in snowpack will correspond with an earlier peak runoff of snowmelt, and increased streamflows earlier in the year (see above).

Other effects of warmer temperatures on snowmelt hydrology have been well understood for decades, and the effects of global warming on Pacific Northwest rivers has been quantified in a number of published studies. In basins with significant snow accumulation in winter, warmer temperatures systematically reduce peak snow accumulation, producing more runoff in winter, earlier peak flows in spring, and reduced water availability in summer. Snowpack at high elevations is generally less sensitive to temperature changes and more sensitive to precipitation changes. Thus, at high elevations, snowpack could increase if winter precipitation increases over time. However, even if there is an increase in snowfall at high elevations, the area covered by high elevations is small relative to the area of an entire river basin and consequently the total snow pack in a river basin typically declines if temperatures rise (even if precipitation increases by a modest amount).

Marine Ecosystems
It is very certain that ocean circulation will continue to change in response to ocean-atmospheric processes occurring at the scale of years to decades (see discussion of ENSO and PDO above). These changes in ocean circulation include the intensity and character of upwelling winds, as well as changes in freshwater input (Water Resources Breakout Group 2004). While the patterns of these variations and their impacts on marine ecosystems (e.g., persistent changes in ecosystem structure, directional changes in productivity, etc.) are unknown, paleological records and quantified physical dynamics help to shed light on potential projections. Paleo-records suggest

that over long time scales, warm regimes are associated with strong upwelling. It also is known that a warmer continent results in stronger equator-ward winds that fuel upwelling. In combination, these two trends suggest a likely increase in the magnitude and duration of upwelling along the Pacific Northwest coast (Water Resources Breakout Group 2004).

The emergence of a mass of hypoxic (low oxygen) water (a so-called "dead zone") appearing off the central coast of Oregon in 2002 and 2004 may signal an unanticipated consequence of climate change mediated through changes in ocean circulation.

Projections about climate change in the region also indicate the potential for:

- Influx of seawater into estuaries and lower reaches of rivers due to sea-level rise,
- An earlier influx of freshwater into estuarine and coastal areas,
- Greater seasonal variation, and
- Increased stress on estuarine and nearshore species that are physiologically adapted to particular patterns in physical characteristics of their habitats (e.g., salinity).

Terrestrial Ecosystems

Changes in temperature and precipitation patterns are likely, but the manner in which these changes will affect the terrestrial ecosystems of the Pacific Northwest is poorly known. Likely impacts include shifts in species composition and timing of the growing season, but the details are unpredictable. For example, temperature changes and loss of snowpack are expected to affect forests, particularly those in southwest, central, and eastern Oregon that rely on snowpack for water. Given current biomass densities, the anticipated drier summers will increase drought stress and vulnerability of forests to insects and diseases, and may ultimately lead to widespread fires that may systematically alter the hydrologic response in river basins over time.

What are the greatest areas of uncertainty affecting our ability to understand and predict likely climate change in the Pacific Northwest?

Shifts in regional-scale climate forcing, such as precipitation and winds, are the fundamental processes that affect ecosystems. We have little certainty in the projections about these key processes for the Pacific Northwest, and their effects on outcomes such as extreme events (e.g., flooding and large fires). The next level of uncertainty is the response of marine and terrestrial ecosystems to changes in the patterns of variability as well as long-term trends. Lastly, shifts in management practices, urban development, and other human activities will be convolved with changes in the natural environment and will impact ecosystems.

What are the most important questions to be answered in the next 5-10 years?

- What will be the trend and pattern of precipitation in the Pacific Northwest?
- What will be the patterns of coastal ocean winds and associated upwelling events?
- What are the dynamics of large, decadal-scale patterns of ocean/atmosphere interactions?
- Do thresholds exist for abrupt climate change and system shifts?
- How will the aforementioned patterns affect ecosystem patterns and resilience (including the maintenance of processes and patterns in the face of variability)?

What are the priorities for future research?
The priorities should be based on answering the four questions listed above. To accomplish this, we need to invest in four areas of research.

1. Improved and sustained observations of critical processes that can resolve interannual/decadal-scale variability. These observing systems should be focused on both physical and biological variables, and should be of sufficient quality to resolve local, small-scale processes relative to climate signals.
2. Focused process experiments and studies of critical processes, such as the impacts of increased CO_2 on forest dynamics and the impact of changes in the upwelling regime on coastal marine ecosystems and fisheries.
3. Improved numerical and statistical models focused on coupled atmosphere/ocean/land processes that include ecological as well as geophysical dynamics. Particular emphasis should be on developing regional-scale projections. Close interaction between modeling and analysis and the observing programs should be ensured.
4. Modeling and analysis of the effects of economic and management policies interannual/decadal-scale processes in the Pacific Northwest. This could include forest management, land use changes, fishery management, coastal zone management and water policy.

Appendix A – Consensus Process and Participants

On June 15, 2004, a symposium entitled "Impacts of Climate Change on the Pacific Northwest" was held to provide invited Oregon and Washington-based scientists an opportunity to: 1) share knowledge concerning the present status of global climate change research and regional greenhouse gas emission reduction strategies, 2) share findings on scenarios for climate change and possible impacts in the Pacific Northwest, and 3) identify areas of consensus and uncertainty. Sixty-five people attended the meeting. Participants were primarily scientists working in a variety of fields related to climate change in the Pacific Northwest, such as oceanography, forest ecology, forest economics, agriculture and resource economics, hydrology, paleoclimatology, marine ecology, fisheries biology, estuarine ecology, population biology, geography, ornithology, climatology, and meteorology. Attendees also included a diversity of observers, such as members of the Advisory Group and agency staff providing technical support to the Advisory Group, media, and other individuals working on issues related to climate change policy.

Pre-meeting questionnaires were distributed to participants. Four experts presented overview of scientific understanding in key areas. Responses to the pre-meeting questionnaires, the slideshow presentations, extended abstracts of the presentations, and summaries of four breakout group sessions (terrestrial ecosystems, marine ecosystems, water resources, and the Pacific Northwest as a system) are available as part of the meeting proceedings online at http://inr.oregonstate.edu/policy/climate-change.html.

This Consensus Statement, drafted by a subcommittee of participants and circulated to other participants for review and sign-on, is also part of the proceedings. The statement is signed by 50 Ph.D.-level scientists with expertise on the impacts of climate change in the Pacific Northwest. Names of the signatories appear below.

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Appendix B – Overview of Findings from the Third Assessment Report of the Intergovernmental Panel on Climate Change

(Excerpted from *Climate Change 2001: Synthesis Report – Summary for Policymakers, an Assessment of the Intergovernmental Panel on Climate Change*. This summary, approved in detail at IPCC Plenary XVIII (Wembley, United Kingdom, 24-29 September 2001), represents the formally agreed statement of the IPCC concerning key findings and uncertainties contained in the Working Group contributions to the Third Assessment Report.)

Table SPM-1 20th century changes in the Earth's atmosphere, climate, and biophysical system.[a]

Indicator	***Observed Changes***
Concentration indicators	
Atmospheric concentration of CO_2	280 ppm for the period 1000–1750 to 368 ppm in year 2000 (31±4% increase).
Terrestrial biospheric CO_2 exchange	Cumulative source of about 30 Gt C between the years 1800 and 2000; but during the 1990s, a net sink of about 14±7 Gt C.
Atmospheric concentration of CH_4	700 ppb for the period 1000–1750 to 1,750 ppb in year 2000 (151±25% increase).
Atmospheric concentration of N_2O	270 ppb for the period 1000–1750 to 316 ppb in year 2000 (17±5% increase).
Tropospheric concentration of O_3	Increased by 35±15% from the years 1750 to 2000, varies with region.
Stratospheric concentration of O_3	Decreased over the years 1970 to 2000, varies with altitude and latitude.
Atmospheric concentrations of HFCs, PFCs, and SF_6	Increased globally over the last 50 years.
Weather indicators	
Global mean surface temperature	Increased by 0.6±0.2°C over the 20th century; land areas warmed more than the oceans (*very likely*).
Northern Hemisphere surface temperature	Increase over the 20th century greater than during any other century in the last 1,000 years; 1990s warmest decade of the millennium (*likely*).
Diurnal surface temperature range	Decreased over the years 1950 to 2000 over land: nighttime minimum temperatures increased at twice the rate of daytime maximum temperatures (*likely*).
Hot days / heat index	Increased (*likely*).
Cold / frost days	Decreased for nearly all land areas during the 20th century (*very likely*).
Continental precipitation	Increased by 5–10% over the 20th century in the Northern Hemisphere (*very likely*), although decreased in some regions (e.g., north and west Africa and parts of the Mediterranean).
Heavy precipitation events	Increased at mid- and high northern latitudes (*likely*).
Frequency and severity of drought	Increased summer drying and associated incidence of drought in a few areas (*likely*). In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades.

➔

Box SPM-1 Confidence and likelihood statements.

Where appropriate, the authors of the Third Assessment Report assigned confidence levels that represent their collective judgment in the validity of a conclusion based on observational evidence, modeling results, and theory that they have examined. The following words have been used throughout the text of the Synthesis Report to the TAR relating to WGI findings: *virtually certain* (greater than 99% chance that a result is true); *very likely* (90–99% chance); *likely* (66–90% chance); *medium likelihood* (33–66% chance); *unlikely* (10–33% chance); *very unlikely* (1–10% chance); and *exceptionally unlikely* (less than 1% chance). An explicit uncertainty range (±) is a *likely* range. Estimates of confidence relating to WGII findings are: *very high* (95% or greater), *high* (67–95%), *medium* (33–67%), *low* (5–33%), and *very low* (5% or less). No confidence levels were assigned in WGIII.

Table SPM-1 20th century changes in the Earth's atmosphere, climate, and biophysical system.[a] (continued)	
Indicator	***Observed Changes***
Biological and physical indicators	
Global mean sea level	Increased at an average annual rate of 1 to 2 mm during the 20th century.
Duration of ice cover of rivers and lakes	Decreased by about 2 weeks over the 20th century in mid- and high latitudes of the Northern Hemisphere (*very likely*).
Arctic sea-ice extent and thickness	Thinned by 40% in recent decades in late summer to early autumn (*likely*) and decreased in extent by 10–15% since the 1950s in spring and summer.
Non-polar glaciers	Widespread retreat during the 20th century.
Snow cover	Decreased in area by 10% since global observations became available from satellites in the 1960s (*very likely*).
Permafrost	Thawed, warmed, and degraded in parts of the polar, sub-polar, and mountainous regions.
El Niño events	Became more frequent, persistent, and intense during the last 20 to 30 years compared to the previous 100 years.
Growing season	Lengthened by about 1 to 4 days per decade during the last 40 years in the Northern Hemisphere, especially at higher latitudes.
Plant and animal ranges	Shifted poleward and up in elevation for plants, insects, birds, and fish.
Breeding, flowering, and migration	Earlier plant flowering, earlier bird arrival, earlier dates of breeding season, and earlier emergence of insects in the Northern Hemisphere.
Coral reef bleaching	Increased frequency, especially during El Niño events.
Economic indicators	
Weather-related economic losses	Global inflation-adjusted losses rose an order of magnitude over the last 40 years (see Q2 Figure 2-7). Part of the observed upward trend is linked to socio-economic factors and part is linked to climatic factors.

[a] This table provides examples of key observed changes and is not an exhaustive list. It includes both changes attributable to anthropogenic climate change and those that may be caused by natural variations or anthropogenic climate change. Confidence levels are reported where they are explicitly assessed by the relevant Working Group. An identical table in the Synthesis Report contains cross-references to the WGI and WGII reports.

Appendix C – References

Abbott, M. 2004. Impacts of Climate Change on the Coastal Ocean. Presentation at the June 14, 2004 Impacts of Climate Change on the Pacific Northwest Meeting, Oregon State University, Corvallis, Oregon. Available at http://inr.oregonstate.edu/policy/climate_abbott_files/frame.htm.

Fazio, J. et al. *In review*. Potential Impacts of Climate Change in the Pacific Northwest. Draft assessment report to the Northwest Power and Conservation Council, Portland, Oregon.

Intergovernmental Panel on Climate Change, Working Group I. 2001. Climate Change 2001: Synthesis Report – Summary for Policymakers, an Assessment of the Intergovernmental Panel on Climate Change. Third Assessment Report. World Meteorological Organization, Geneva, Switzerland. 34 pp.

Marine Ecosystems Breakout Group. 2004. Summary of breakout group discussion at the June 14, 2004 Impacts of Climate Change on the Pacific Northwest Meeting, Oregon State University, Corvallis, Oregon. Available at http://inr.oregonstate.edu/policy/climate_marine_breakout_presentation_files/frame.htm.

Miles, E. 2004. Climate Change Impacts in the Pacific Northwest. Presentation at the June 14, 2004 Impacts of Climate Change on the Pacific Northwest Meeting, Oregon State University, Corvallis, Oregon. Available at http://inr.oregonstate.edu/policy/climate_miles_files/frame.htm.

Mote, P. W. 2003. Trends in temperature and precipitation in the Pacific Northwest during the twentieth century. *Northwest Science* 77(4): 271-282.

Stewart, I. T. et al. *In review*. Changes toward earlier streamflow timing across western North America. Journal of Climate.

Terrestrial Ecosystems Breakout Group. 2004. Summary of breakout group discussion at the June 14, 2004 Impacts of Climate Change on the Pacific Northwest Meeting, Oregon State University, Corvallis, Oregon. Available at http://inr.oregonstate.edu/policy/climate_breakout_terrestrial.pdf.

U.S. Global Change Research Program, National Assessment Synthesis Team. 2001. Potential Consequences of Climate Change Variability and Change for the Pacific Northwest. Chapter 9 in Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Cambridge University Press, Cambridge, United Kingdom. 612 pp.

Water Resources Breakout Group. 2004. Summary of breakout group discussion at the June 14, 2004 Impacts of Climate Change on the Pacific Northwest Meeting, Oregon State University, Corvallis, Oregon. Available at http://inr.oregonstate.edu/policy/climate_breakout_water.pdf.

Appendix D

Briefing Paper — Materials and Greenhouse Gases

Prepared for the Governor's Advisory Group on Global Warming
by David Allaway, Oregon Department of Environmental Quality (DEQ)

April 27, 2004

This paper provides background information for members of the Governor's Advisory Group on Global Warming. Topics covered include:

∉ An overview of materials and waste in Oregon, including key definitions.
∉ An introduction to materials-related greenhouse gas sources and sinks.
∉ The rationale for developing a supplemental accounting of materials-related greenhouse gases.
∉ An overview of this supplemental accounting.
∉ An introduction to the basic methods of reducing materials-related greenhouse gas emissions, including waste reduction, energy recovery, and landfill controls.

The work of the Technical Subcommittee on Materials Use, Recovery and Disposal will be presented to the Advisory Group in two parts.

1. At the Advisory Group's May 12 meeting, the topics listed above will be summarized and time will be available for discussion.
2. Results of the supplemental materials accounting and the evaluation of specific materials-related measures (program and policy options) will be summarized at the Advisory Group's June 13 meeting for discussion at that time. Written materials will be forwarded in advance of that meeting.

Scope and Background: Materials and Waste in Oregon

The scope of the Technical Subcommittee on Materials Use, Recovery, and Disposal includes emissions and offsets associated with the production, use, recycling, composting, incineration, and landfilling of materials. The focus is on materials *used by and discarded by* Oregonians, as opposed to all materials *made in* Oregon. These include the many different types of materials that Oregon households and businesses discard for recycling, composting, or garbage collection.

The following types of materials are not addressed in this evaluation:

∉ Materials exported for *use out of state*. The in-state emissions associated with production and transportation of these materials are addressed by the energy and transportation subcommittees.
∉ Materials used in Oregon that are disposed of in wastewater systems, such as food and tissues. Some impacts from related wastewater processes (such as methane and nitrous oxide emissions from wastewater treatment plants) are addressed by the Technical Subcommittee on Other Greenhouse Gases.
∉ Materials managed as hazardous wastes and industrial and agricultural process wastes, such as slash from timber operations and crushed rock from mining, and materials exempted from the statutory definition of "counting" solid wastes, such as junked cars.

Once a material is no longer wanted by an Oregon household or business, it becomes a "waste". Roughly 35 percent of wastes discarded in Oregon in 2002 were either recycled or composted. The remaining wastes were either incinerated or sent to solid waste landfills. Most garbage in Oregon is landfilled, and Oregon is also one of the West's largest importers of garbage. In 2002, Oregon landfilled approximately

2.6 million tons of municipal solid waste from inside Oregon and another 1.4 million tons from other states, primarily Washington.

Some wastes, such as tires, dimensional lumber and used motor oil, are kept separated from mixed wastes and are burned as fuels by industry. In addition, Oregon has two mixed waste incinerators. Marion County's incinerator recovers energy while Coos County's does not. Approximately 12 percent of wastes discarded in Oregon in 2002 were burned for energy.

In addition to these known quantities of waste, which DEQ counts annually, an unknown quantity of waste is burned on-site or dumped in backyards or public lands.

A few notes regarding terminology: **Disposal** includes both disposal of waste at landfills and most disposal at garbage incinerators. **Waste recovery** includes recycling and composting, and in certain cases, thermal recovery of energy from waste. **Waste generation** is defined as the sum of disposal and recovery. It is largely synonymous with what households and businesses discard. **Waste prevention** means making less waste in the first place, such as more efficient use of materials. Waste prevention and **reuse** differ from recycling. In reuse, materials are used again in their original form, without the repulping, melting, grinding, or other mechanical or chemical reformulation associated with recycling. Finally, the term **waste reduction** incorporates all activities that reduce disposal, including waste prevention, reuse, recycling, and composting.

Per-capita waste generation (discards), as counted by DEQ, has risen more than 30 percent between 1992 and 2002. DEQ is currently evaluating this trend in an attempt to determine its causes. Some of the increase is explained by better reporting. Shifts in waste from on-site management such as backyard burning (which isn't counted in generation) to the system of recycling, composting and disposal (which are counted) also explain some of the rise in per-capita generation. Increases not attributed to better reporting and waste shifting are most likely attributable to increasing use, recovery, and disposal of resources.

Oregon statute includes a **waste management hierarchy**, which states that the preferred order for managing wastes are prevention, followed by reuse, followed by recycling, then composting, then energy recovery, and finally landfilling as the least preferred option. Also contained in law are **waste generation goals** and **waste recovery goals**, as follows:

- In 2005 and subsequent years, no increase in per-capita waste generation.
- In 2005, a waste recovery goal of 45 percent.
- In 2009 and subsequent years, no increase in total waste generation.
- In 2009, a waste recovery goal of 50 percent.

The state's waste recovery rate includes recycling and composting, as well as some energy recovery, and some adjustments for reuse and home composting. In 2002, the state's recovery rate was 46.6 percent. DEQ is concerned that the rate for 2003, which is currently being calculated, will fall as energy recovery from wood waste declined due to poor market conditions.

Materials-Related Greenhouse Gas Sources and Sinks

Greenhouse gas emissions and reductions associated with the production, recovery and disposal of materials and wastes are numerous and complex. In the United States, the U.S. Environmental Protection Agency's (EPA's) Office of Solid Waste and Emergency Response (OSWER) has funded and published some of the most comprehensive and definitive research on these topics.

The categories of emissions (sources) and offsets (reductions and sinks) recognized by OSWER include the following:

1. **Fossil fuel-derived energy in manufacturing** and natural resource extraction. This includes direct combustion of fossil fuels (for example, natural-gas fired boilers at paper mills) and the use of fossil fuels to generate electricity used by industry.
2. **Non-energy emissions from industrial processes**, such as carbon dioxide (CO_2) emissions from converting limestone to lime (used in the production of steel and aluminum) and methane emissions from natural gas processing associated with the manufacture of plastic products.
3. **Transportation-related emissions** including transporting raw materials to industry, manufactured products to customers, and discards to recovery and waste disposal facilities.
4. **Carbon storage in wood products and indirect carbon storage in forests** (related to changes in demand for timber as a result of recycling and reducing use of paper and wood). Increasing use of wood products increases the amount of carbon stored in products, while decreasing demand for timber is projected to indirectly increase carbon storage in forests.
5. **Carbon storage in agricultural soils** amended with composted wood, yard debris, and/or food waste. Soils that have been depleted of carbon have the potential to store carbon if treated with finished compost. (CO_2 from the decomposition or combustion of plant-based wastes is typically considered part of the natural carbon cycle and is not counted in most greenhouse gas inventories.)
6. **Methane emissions from landfills**. In the oxygen-poor landfill environment, a portion of carbon in waste is converted to methane. Many large landfills capture a portion of this methane and convert the carbon back to CO_2 through combustion.
7. **Carbon storage in landfills**. Slow-to-degrade materials, such as wood, may increase carbon sequestration if disposed of in landfills, thus offsetting methane emissions.
8. **Emissions from incineration of wastes**. These include nitrous oxide as well as CO_2 from the combustion of fossil carbon-derived materials such as tires, plastics, and synthetic textiles.
9. **Offsets from reductions in fossil fuel use resulting from energy recovery** of incinerated wastes or methane collected at landfills. Incinerators that recover energy from waste, and landfills that recovery energy from methane, offset the combustion of other fossil fuels elsewhere.

For any given material, several of these types of emissions and reductions or sinks may be relevant. For example, when comparing the recycling vs. disposal of paper, relevant categories of emissions include industrial energy for production of virgin and post-consumer paper, transportation, carbon storage in forests, methane emissions from landfills, carbon storage in landfills, and fossil fuel offsets from landfill gas energy recovery.

The relative importance of each of these types of emissions also varies widely between materials. For example, grass clippings, when landfilled, can produce significant quantities of methane, a potent greenhouse gas. In contrast, plastics and glass are relatively inert in landfills and generate little or no methane. For glass and plastic, their greenhouse gas profiles are dominated by manufacturing and transportation. Lawn prunings, on the other hand, are not manufactured and thus have no manufacturing-related greenhouse gas impacts.

One further complication is that some emission and reduction effects occur immediately, while others are delayed and extended over multiple years. For example, when material is disposed in a dry landfill, it may slowly generate methane for 100 – 150 years, or more. Depending on the accounting system used, landfill-related benefits of waste reduction may be assigned either to the year in which the waste reduction occurs, or in small increments in each of the years in which resulting methane emissions are reduced. The latter approach is used in this project. Landfill emissions in the year 2015, for example, are modeled as actual emissions *in that year* from waste disposed of in all previous years. Emission reductions associated with carbon storage benefits at landfills, compost-amended soils, and forests (indirect) are also treated as occurring over multiple years. Advisory Group members should be aware that for some program and policy measures, actual emission reductions, over time, will be greater than what is estimated for the years 2015 and 2025.

Limitations of EPA's State Inventory Tool and Oregon's Inventory – The Need for a Supplemental Accounting of Materials-Related Greenhouse Gases

The EPA's State Inventory Tool provides a framework for inventorying a state's greenhouse gases. Oregon has chosen to use the State Inventory Tool (SIT) in support of the Advisory Group's work, with one major modification. Whereas the SIT assigns emissions from combustion of fossil fuels for electricity generation to the state where the electricity is generated, Oregon is choosing to assign these emissions to the state where the electricity is used. Thus, Oregon is assigned the emissions associated with the electricity we *use*, as opposed to the emissions from the electricity we *produce*. In other words, greenhouse gases associated with electricity generation are assigned to the state that is home to the *user* of the electricity, regardless of whether the electricity is generated in or out of state.

In contrast, state greenhouse gases associated with materials production are assigned not to the *user* of the material but rather the *producer*.

A consequence of this approach is that energy conservation and materials conservation are treated inconsistently. If Oregon is successful at reducing electricity use or shifting electricity purchases to non-fossil sources, Oregon will be assigned 100 percent of the reduction in emissions under the state's inventory. But if Oregon is successful at reducing waste, then reductions in upstream (manufacturing) emissions, which are often significant, will be assigned to the state where the material is produced (or where recycled wastes displace virgin feedstocks). Since many materials used in Oregon are not manufactured here, only a fraction of the benefit of waste reduction would be assigned to Oregon.

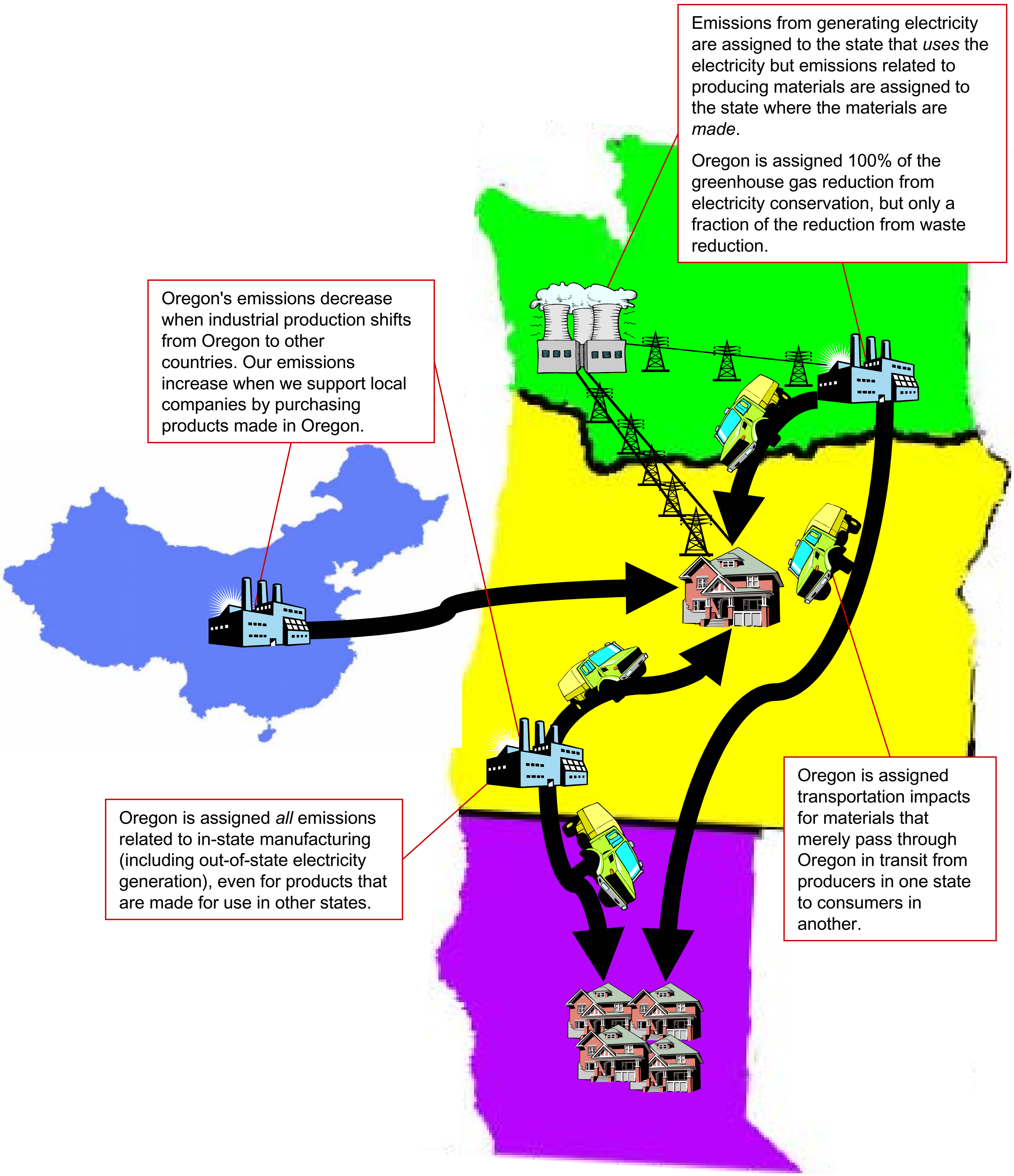
Other challenges with the SIT and Oregon's inventory framework include the following:

- Because resource extraction and manufacturing impacts are assigned entirely to the state (or nation) where the resource extraction and manufacturing occurs, out-of-state (or nation) consumers are assigned none of these impacts. All responsibility is assigned to the producer; none is shared with the consumer.
- Materials manufactured in state X, and shipped (by truck) through Oregon on their way to state Y for sale, cause Oregon to be assigned a portion of transportation impacts, even though Oregon neither produces nor uses the materials.
- Under both the SIT and Oregon's inventory, the shifting of production from Oregon to another state or country would be counted as an emissions reduction, even if global consumption and associated CO_2 emissions were unchanged. Conversely, if Oregon households and businesses shift consumption to locally-produced materials, a likely outcome of Oregon's inventory is that Oregon's greenhouse gas profile would appear to rise, even as global emissions probably fall (all other things being equal).

These issues are illustrated graphically in Figure 1.

Figure 1.

Oregon's Greenhouse Gas Inventory - How it Accounts for Material Production and Consumption



Our Solution: A Supplemental Accounting

The Technical Committee has decided not to make direct adjustments to the EPA's State Inventory Tool as part of this evaluation effort, other than for electricity. Instead, the Materials Subcommittee is developing a supplemental accounting of materials-related emissions. This supplemental accounting is being performed as a series of side calculations to the inventory. Results of the supplemental accounting will not be added to the Oregon inventory in order to avoid double-counting. However, this supplemental accounting will establish a framework whereby Oregon will be able to account for greenhouse gas reductions resulting from waste reduction initiatives in Oregon, even if they lead to changes in production and transportation outside of the state. Results of the supplemental accounting will be presented at the June 13 meeting of the Governor's Advisory Group and will also be shared with the EPA and the States of Washington and California in support of the activities of Working Group #5 (protocols).

In its simplest form, the supplemental accounting uses DEQ and EPA data on the composition of materials disposed and recovered in Oregon, as well as national sales, production, import, and export data to develop a model of materials use and discards in Oregon. For each type of material, EPA Office of Solid Waste and Emergency Response (OSWER) emissions factors for production, recycling, composting, landfilling, etc. are then applied. Adjustments are being made to some of these emissions factors to reflect Oregon-specific conditions, and to account for manufacturer-to-consumer transportation emissions, which were not included in OSWER's report.

Figure 2 illustrates the materials-related differences in what is included and excluded by the Oregon inventory and the Oregon supplemental accounting.

Strategies for Reducing Materials-Related Greenhouse Gases

Given the types of emissions noted above, three basic strategies for reducing greenhouse gases are:
1. Reduce fossil fuel use by waste prevention (more efficient use of products and packaging, reuse, using less), recycling of certain materials, and energy recovery from wastes and methane.
2. Increase carbon storage. Carbon storage can be increased in wood products, in soils (by composting and applying that compost to carbon-depleted soils), and in landfills (by landfilling certain carbonaceous materials). Indirect carbon storage can be increased in forests by recycling paper and preventing waste.
3. Reduce methane from landfills by reducing the landfilling of materials with large methane generating potential, controlling landfill conditions, and capturing methane emissions.

The Materials Subcommittee is currently evaluating a wide variety of materials- and waste-related measures. These will be presented to the Governor's Advisory Group at its June 13 meeting. The types of measures under study include both programmatic and policy changes. Examples include:
- Provide financial incentives or require enhanced methane collection at landfills (and energy recovery from that methane).
- Decrease the on-site burning of wastes, particularly fossil-carbon derived materials (plastics, tires, etc.) through education and/or increased regulation or enforcement.
- Provide additional funding to support the establishment and/or maintenance of enhanced waste reduction programs, such as food waste composting.
- Ban disposal in landfills of materials such as yard debris and recyclable paper, where the recovery infrastructure is well established.

(continues, next page)

Figure 2.
Comparison of Oregon's Inventory and Materials-Related Supplemental Accounting

Type of Emissions	Oregon Inventory (SIT with adjustment for electricity generation)	Oregon Supplemental Accounting (materials-related)
Raw Materials Extraction, Product Manufacturing, and Transport of Products to Consumer		
Products made in Oregon		
and used/discarded in Oregon	Included[a]	Included
and used/discarded elsewhere	Included[a]	Excluded
Products made outside Oregon		
and used/discarded in Oregon	Excluded	Included
and used/discarded elsewhere	Excluded	Excluded
Municipal Solid Waste Disposal in Oregon (methane emissions)		
Waste generated in Oregon	Included	Included
Waste generated elsewhere and imported to Oregon	Included[b]	Included[b]
Waste Combustion in Oregon	Included	Included
Carbon Sequestration		
In landfills: yard debris	Included	Included
In landfills: other wastes	Excluded	Included
In compost	Excluded	Included
In wood products (in use)	Excluded	Included
In forests (indirect, resulting from waste reduction)	Excluded	Included

[a]Accounted for in non-waste modules (electricity use, industrial energy use, transportation fuel use).
[b]Only landfill-related methane emissions are counted for imported waste.

- Require loads of mixed waste to be sorted prior to disposal in high-population counties.
- Expand the bottle bill to cover more materials and/or increase the deposit value to reverse the decline in redemption rates.
- Encourage the more efficient use of materials (waste prevention) through education and incentives.

Advisory Group members with questions regarding the work of the Technical Subcommittee on Materials Use, Recovery and Disposal are welcome to contact the Subcommittee Chair directly at the following:

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Appendix E

West Coast Governors' Global Warming Initiative Staff Recommendations to the Governors[1]

November, 2004

Executive Summary

Global warming will have serious adverse consequences on the economy, health and environment of the West Coast states. These impacts will grow significantly in coming years if we do nothing to reduce greenhouse gas pollution. Fortunately, addressing global warming carries substantial economic benefits. The West Coast region is rich in renewable energy resources and advanced energy-efficient technologies. We can capitalize on these strengths and invest in the clean energy resources of our region.

Recognizing these facts, the Governors of California, Oregon, and Washington launched the West Coast Governors' Global Warming Initiative in September 2003. They committed the states to acting "individually and regionally to reduce greenhouse gas emissions" through strategies that "provide long-term sustainability for the environment, protect public health, consider social equity, and expand public awareness." They directed their staffs to develop joint policy recommendations focused on, among other things, ways the West Coast states can:

- Use the states' combined purchasing power to obtain fuel-efficient vehicles and low-rolling resistance tires for motor pool fleets.
- Reduce emissions from diesel fuel in transportation through reductions in the use of diesel in ships and trucks.
- Remove barriers to and encourage the development of renewable electricity generation resources and technologies.
- Improve efficiency standards with the potential to reduce greenhouse gas emissions.
- Develop consistent and coordinated greenhouse gas emission inventories and reporting protocols and collaborate on scientific tools to measure the impact of climate change.

[1] This report was prepared by the Executive Committee of the West Coast Governors' Global Warming Initiative, comprised of Carol Jolly and Ron Shultz from Washington; David Van't Hof and Stephen Schneider from Oregon; and Bob Therkelsen and Anne Baker from California.

This initiative was well-received by the public and the media around the world. It is widely considered one of the top two or three state initiatives on climate change in the United States. (See Appendix A for selected press clippings.)

Workgroups with representatives from the three states were created to address each of the five areas. An additional sixth group on hydrogen was created later. Draft recommendations from the original five groups were made available for public review and comment in April 2004. The final list of recommendations includes, among other things:

1. Set new targets for improvement in performance in average annual state fleet greenhouse gas emissions.
2. Collaborate on the purchase of hybrid vehicles.
3. Establish a plan for the deployment of electrification technologies at truck stops in each state on the I-5 corridor, on the outskirts of major urban areas, and on other major interstate routes.
4. Set goals and implement strategies and incentives to increase retail energy sales from renewable resources by one percent or more annually in each state through 2015.
5. Adopt energy efficiency standards for eight to 14 products not regulated by the federal government, establishing a cost-effective efficiency threshold for all products sold on the West Coast.
6. Incorporate aggressive energy efficiency measures into updates of state building energy codes, with a goal of achieving at least 15 percent cumulative savings by 2015 in each state.
7. Organize a West Coast Governors' conference in 2005 to inform policy-makers and the public of climate change research concerning the West Coast states.

The Executive Committee recommends that the three Governors direct the staffs of their states to implement the recommendations in this report.

It also is clear that significant policies beyond the workgroup recommendations will be needed to meet the Governors' goal of reducing the states' greenhouse gas emissions below current levels. In addition to working together on the workgroup topic areas, each state has created its own stakeholder process to develop a more comprehensive list of recommendations for state-based climate protection strategies. These processes are in different stages in each state, and many significant new policies and measures are under consideration. Going forward, activities under this regional initiative should be coordinated with what emerges from those stakeholder groups.

The Governors should give careful consideration to four actions under consideration in one or more of the stakeholder processes that offer the most promise for achieving greenhouse gas emission reductions:

- Adopting comprehensive state and regional goals for greenhouse gas emissions reductions;
- Adopting standards to reduce greenhouse gas emissions from vehicles;
- Developing a regional market-based carbon allowance program; and,
- Expanding the markets for efficiency, renewable energy, and alternative fuels.

The Executive Committee recommends that the Governors continue the efforts of this West Coast Initiative over the coming year and direct the Initiative to focus its efforts on assessing the feasibility of regional greenhouse gas emission reduction strategies that arise out of the state stakeholder processes, with particular emphasis on those listed above.

We are confident that by working together, the West Coast States can take a global leadership position in reducing greenhouse gas emissions and combating global warming—while setting the stage for strong, long-term economic growth.

Appendix F

Glossary of Energy and Global Warming Terms

Average Megawatt (aMW)—An average megawatt is 8,760 megawatt hours. This is the continuous output of a resource with one megawatt of capacity over a full year. One aMW provides enough electric energy for about 730 Oregon homes for one year.

Biofuels—Alcohols, ethers, esters, and other chemicals made from raw biological material such as herbaceous and woody plants, agricultural and forestry residues, and a large portion of municipal solid and industrial waste.

Biological Sequestration—The fixation of atmospheric carbon dioxide in a carbon sink through physical or biological processes, such as photosynthesis. Also called bio-sequestration or carbon sequestration.

Biomass—Organic waste that is considered a renewable energy source. It includes organic waste from agricultural, livestock and lumber industry products, dead trees, and foliage, etc. Biomass can be used as fuel and is most often burned to create steam that powers steam turbine generators. It also is used to make transportation fuels like ethanol and biodiesel.

Btu—British thermal unit; the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit under stated conditions of pressure and temperature (equal to 252 calories, 778 foot-pounds, 1,005 joules and 0.293 watthours). It is the U.S. customary unit of measuring the quality of heat, such as the heat content of fuel.

Carbon Dioxide Offset—A mechanism by which the impact of emitting a ton of CO_2 can be negated or diminished by avoiding the release of a ton elsewhere or by absorbing a ton of CO_2 from the air that otherwise would have remained in the atmosphere.

Carbon Sequestration—See Biological Sequestration**.**

Carbon Sink—A reservoir that absorbs or takes up released carbon from another part of the carbon cycle. Vegetation and soils are common carbon sinks.

CH_4—Methane, a greenhouse gas.

CHP—Combined Heat and Power. See Cogeneration.

CO—Carbon Monoxide, a pollutant regulated by the federal Clean Air Act.

CO_2—Carbon Dioxide, a greenhouse gas.

Cogeneration—Also called combined heat and power. The generation of electrical and thermal energy where both forms of energy are put to productive use. The addition of cogeneration capability to generating facilities and industries that produce large amounts of heat energy helps ensure that waste heat (usually in the form of hot water or steam) is used efficiently for heating, industrial use, agriculture or conversion into electricity.

Cooperative Electric Association or Utility—Utility owned and operated by its members.

Consumer-Owned Utilities (COUs) —A term that includes municipal electric utilities, people's utility districts (PUDs) and rural electric cooperatives.

Demand—The rate at which electric energy is delivered to or by a system or part of a system, generally expressed in kilowatts (kW), megawatts (MW), or gigawatts (GW) at a given instant.

Distillate Fuel Oil—Light fuel oils distilled during the refining process and used primarily for space heating, on-and-off highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation.

Distribution—The delivery of electricity to the retail customer's home or business through low voltage distribution lines.

DOE—U.S. Department of Energy. Also called USDOE. See Oregon Department of Energy (ODOE).

Electric Energy—The generation or use of electric power by a device over a period of time, expressed in kilowatt-hours (kWh), megawatt-hours (MWh), or gigawatt-hours (GWh).

Energy Conservation—Using less energy, either by greater energy efficiency or by decreasing the types of applications requiring electricity or natural gas to operate.

Energy Efficiency—Using less energy (electricity and/or natural gas) to perform the same function at the same level of quality. Programs designed to use energy more efficiently (doing the same with less).

EPA—U.S. Environmental Protection Agency.

Fossil Fuels—Sources of carbon-based energy from the earth, primarily crude oil, natural gas and coal.

Fuel Switching—The substitution of one type of fuel for another, either temporary or permanent. Permanent might include someone who replaces an electric water heater with a gas-fired water heater.

Geothermal Energy—The energy from the internal heat of the earth; it may be residual heat, friction heat, or a result of radioactive decay. The heat is found in rocks and fluids at various depths and can be extracted by drilling or pumping.

Green Tags—Certificates or tags created when a renewable energy facility generates electricity. Each green tag represents all of the environmental attributes or benefits of a specific quantity of renewable generation. Those include the benefits that everyone receives when conventional fuels, such as coal, oil or gas are displaced.

Greenhouse Effect—This effect is the result of the mixture of gases in the atmosphere that surrounds the earth. This mixture traps, as heat, some of the solar energy that enters the atmosphere, maintaining a temperature range within certain limits that sustains life on the planet as we know it. Without this natural effect, scientists estimate that temperatures would be over 50 degrees F. cooler, too cold to be habitable. Conversely, too thick a mixture, or "blanket," of these greenhouse gases can overheat the surface of the earth and affect habitability.

Greenhouse Gases (GHGs)—Molecules in the atmosphere that affect the radiative properties of the atmosphere and thereby the global climate. GHGs include water vapor, carbon dioxide, tropospheric ozone, nitrous oxide, methane, and numerous types of halons, such as chlorofluorocarbons (CFCs), hydrofluorocarbos (HFCs), hydroclorofluorcarbons (HCFCs), perfluorocarbons (PFCs) and sulfur hexafluroride (SF_6).

Grid—A system of interconnected power lines and generators that is managed so that power from generators is dispatched as needed to meet the requirements of the customers connected to the grid at various points.

Intelligent Transportation Systems (ITS)—To make travel through and around areas safer and more efficient, ITS uses electronics, computers and communications equipment to collect information, process it, and take appropriate actions. ITS technologies can monitor traffic, manage traffic flow, provide alternate routes to travelers, manage incidents and provide other beneficial uses.

Investor Owned Utility (IOU)—Common term for a privately owned (shareholder owned) gas or electric utility regulated by the Oregon Public Utility Commission.

Kilowatt (kW)—A measure of power delivered (rate of energy flow). It is used to measure the peak use for commercial or industrial utility customers, generally billed on the customer's peak monthly demand.

Kilowatt-hour (kWh)—This is a measure of electric energy consumption over a specified time period (cumulative energy flow), typically a one-month period for billing purposes. Customers are charged a rate per kWh of electricity used.

Liquefied Natural Gas (LNG)—Natural gas (primarily methane) that has been liquefied by reducing its temperature to minus 260 degrees Fahrenheit at atmospheric pressure.

Load—Amount of power that must be generated at power plants to serve customer electric demands. It must account for the amount of power that customers use and the amount lost in the transmission and distribution system. The amount generated is measured in kilowatts (kW) or megawatts (MW).

Load-based Greenhouse Gas Allowance Standard—A limitation placed on the greenhouse gas emissions associated with the energy deliverer (e.g., usually by an electric or gas utility, but potentially any large emitter of greenhouse gases). The standard governs the amount of carbon dioxide (or all greenhouse gases) that can be released in connection with an amount of energy generated to serve customer loads (a residence, business or institution that uses energy).

Methane—CH_4. A greenhouse gas formed from decaying organic matter, including animal waste. It is the primary component of natural gas.

Municipal Utility—Electric utility owned and operated by a city or chartered by a city.

Megawatt (MW)—A megawatt equals 1,000 kilowatts or 1 million watts.

Megawatt-hour (MWh)—A megawatt-hour; the unit of energy equal to that expended in one hour at a rate of one million watts. One MWh equals 3,414,000 Btu.

N_2O—Nitrous Oxide, a greenhouse gas.

NOx—Nitrogen Oxides, pollutants regulated by the federal Clean Air Act.

Northwest Power and Conservation Council (NPCC)— Through the Northwest Power Act of 1980, the U.S. Congress authorized Idaho, Montana, Washington and Oregon to create, as an interstate compact, the Pacific Northwest Electric Power and Conservation Planning Council (now known as the Northwest Power and Conservation Council). The Council is a planning and policy-making body that develops and maintains a regional power plan and a fish and wildlife program to balance the Northwest's environment and energy needs. The Governors of the Northwest states appoint Council members.

Offset—See Carbon Dioxide Offset.

Oregon Department of Energy (ODOE)—State agency created in 1975 to ensure Oregon has an adequate supply of reliable and affordable energy and is safe from nuclear contamination. The agency helps Oregonians save energy, develop clean energy resources, promote renewable energy and clean up nuclear waste. Formerly called the Oregon Office of Energy.

Oregon Public Utility Commission (OPUC or PUC)—The OPUC regulates customer rates and services of the state's investor-owned electric, natural gas and telephone utilities. The Commission does not regulate people's utility districts, cooperatives or municipal utilities except in matters of safety.

PV—Photovoltaic or solar electricity.

Peak Load or Peak Demand—The electric load that corresponds to a maximum level of electric demand within a specified time, usually a year.

People's Utility District—A body of local government that provides utility services, generally electricity and water, in a specified community area.

Public Purpose Charge—Portland General Electric and PacifiCorp must collect fees from consumers within their service areas that are equal to 3 percent of gross revenue as part of Oregon Senate Bill 1149 (1999). This money funds energy conservation, renewable energy, and weatherization and energy assistance to low-income households and public schools in their service territories.

Reliability—Electric system reliability has two components—adequacy and security. Adequacy is the ability of the electric system to supply the aggregate electric demand and energy requirements of the customers at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system facilities. Reliability also refers to the security and availability of natural gas and petroleum supply, transportation and delivery.

Renewable Resources—Renewable energy resources are naturally replenished, but flow-limited. They are virtually inexhaustible in duration, but limited in the amount of energy that is available per unit of time. Some (such as geothermal and biomass) may be stock-limited in that stocks are depleted by use, but on a time scale of decades, or perhaps centuries, they can probably be replenished. Renewable energy resources include biomass, hydro, geothermal, direct solar and photovolatics, and wind. In the future they could also include the use of ocean thermal, wave, and tidal action technologies.

Telecommute (or Telework)—A program allowing an employee to work part-or full-time in a location other than the employer's main office. The program conserves fuel, relieves traffic congestion and improves air quality. The alternate location is often the teleworker's home.

Transmission—Transporting bulk power over long distances.

Utility—A regulated or public entity that exhibits the characteristics of a natural monopoly. In the electric industry, "utility" generally refers to a regulated, vertically integrated monopoly electric company or public body that delivers electricity. "Transmission utility" refers to the regulated owner/operator of the transmission system.

Watt—The unit of measure for electric power or rate of doing work. The rate of energy transfer equivalent to one ampere flowing under pressure of one volt.