THE GOVERNOR'S CLIMATE CHANGE INTEGRATION GROUP

Final Report to the Governor

A Framework for Addressing Rapid Climate Change

State of Oregon, January 2008




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The Oregon Department of Energy published this report on behalf of the Climate Change Integration Group.

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[1] Eliot Rose (Policy Associate, Metro) provided significant contributions on behalf of Rex Burkeholder.
[2] Roger Hamilton (Climate Leadership Initiative) also made significant contributions to the CCIG and this report.
[3] Dave Riley was replaced in mid-2007 by Heidi Logosz, Sustainability Manager of Mt. Hood Meadows.
[4] Justin Klure from the Oregon Department of Energy also helped to staff the CCIG through the end of 2006.

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For copies of the report, see
http://www.oregon.gov/ENERGY/GBLWRM/CCIG.shtml

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A Framework for Addressing Rapid Climate Change

The earth's climate is undergoing unprecedented change as a result of human activity, and this change will have significant effects on all Oregonians, their families, their communities, and their workplaces. A broad scientific consensus tells us that climate change is accelerating, and that it is happening at a speed that was unanticipated even recently. It is urgent that we act now, both to reduce the cause of this earth-transforming crisis by rapidly driving towards a low-carbon economy, and to begin to prepare for and adapt to the changes that mitigation cannot prevent. If we as Oregonians rise to this challenge and make intelligent and well-informed choices, we can minimize the most adverse impacts of changing weather patterns on our lives while producing many benefits – including economic opportunities – by leading the world to an environmentally sustainable and globally competitive state economy.

Governor Ted Kulongoski appointed the Climate Change Integration Group (CCIG) to develop a framework for making these intelligent and well-informed choices. The Governor charged the CCIG to create a preparation and adaptation strategy for Oregon, implement and monitor mitigation measures from the 2004 Oregon Strategy for Greenhouse Gas Reductions (and devise new ones if appropriate), serve as a clearinghouse for Oregon climate change information, and explore new research possibilities related to climate change for Oregon's universities.

In this report, the CCIG proposes that Oregon takes steps toward developing a framework that will assist individuals, businesses, and governments to incorporate climate change into their planning processes. This framework is based upon the following underpinnings:

- **Business-as-Usual is Not Climate as Usual:** A change in the Earth's climate of unprecedented magnitude is now inevitable, but concerted action to reduce greenhouse gases can help reduce the degree to which our climate changes.
- **Our Climate is Changing Faster Than Anticipated:** Recent scientific work indicates that the climate is changing faster that had been anticipated even three years ago[5], and that we may be approaching a less favorable climate regime to sustain Oregon's economic health.
- **Significant Economic Threat:** Research shows that climate change will ultimately produce significant adverse economic impacts on most sectors of Oregon's economy.
- **Significant Human Health Threat:** Climate change brings with it significant new health threats, such as new diseases and new disease vectors.
- **It is Urgent that We Act Now:** A broad scientific consensus tells us that it is urgent that we act immediately to reduce the release of greenhouse gases if we are to keep climate change manageable, and to prepare for the impacts of warming that are now inevitable.

[5] IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

- **There are Significant Costs to Delay:** Waiting to act is not a wise choice, as the costs of inaction in terms of disruptions to the economy far outweigh the costs of implementing mitigation, preparation, and adaptation.
- **Preparation and Adaptation are Mandatory:** The changes to the climate are significant, and will require all parts of civilization – our food, shelter, transportation, and energy systems – to invest considerable thought and capital to successfully prepare and adapt.
- **Uncertainty is a Fact of Life:** Lack of scientific certainty should not preclude action; in fact, continued research will play a key role in our success in preparation and mitigation.
- **Decoupling Our Economy from Greenhouse Gas Emissions:** Since we must reduce our emissions dramatically while facing a growing population, we must decouple the growth in our economy from rising emissions and move rapidly towards a low-carbon economy.
- **An Economic Development Opportunity:** While climate change represents a risk, the transition to a low-carbon economy and climate change preparation activities will not only make Oregon more resilient to a changing climate, but also represents an economic development opportunity that Oregon is particularly well-suited to seize.
- **Solutions Improve Quality of Life:** Many of the solutions we implement will not only make Oregon more resilient to a changing climate and related economic impacts, they also will improve our quality of life.
- **Planning in a Time of Rapid Change and Uncertainty:** We can no longer rely on our past experiences to help us predict and plan for future environments.

Both nature and human culture evolve in response to both average local environmental conditions and to the naturally-occurring range of extremes associated with that average. While these systems have the capacity to accommodate to gradual changes, rapidly changing environmental conditions can tax their ability to adapt. Due to the build-up of greenhouse gases, we are living in a time of rapid change in both averages and extremes. The challenge of climate change for both natural and human systems is that it will create environments that differ significantly from those of recent experience and the past. The complexity and rapidity of these changes will stress the ability of human and natural systems to respond and adapt.

For example, Douglas fir forests, one of Oregon's signature ecosystems, are well-suited to our current conditions of heavy winter rains with little rain in summer. These forests can tolerate the naturally-occurring extremes that they have faced for millennia. However, climate change means that these extremes will become much more common, and that new and harsher extremes will develop. Long-term persistent droughts have the potential to weaken the forest, making them susceptible to debilitating fires and insect infestations, and to alter Oregon's landscape.

Similarly, planning for infrastructure is based upon the average and extreme conditions which our culture has faced for centuries. When determining whether to build near bodies of water, for example, we use the concept of the 100-year floodplain. But the averages and extremes are no longer stable. What are now 100-year flood events are likely to become more frequent. If we build new infrastructure based upon historically-based averages, this infrastructure will face risk and damage not anticipated by our current planning and decision-making processes.

Our rapidly changing climate will affect nearly every aspect of our lives as Oregonians. As nature changes, the human use of nature – in terms of our farms, forests, and fisheries – will be forced to change as well. It will affect our food supply. The types and productivity of crops will change, and the timing of fish runs and relative abundance of marine species will change. Even pristine wilderness untouched by human activity will face disruptions.

In the human-built environment, our transportation system, land use planning, and building design will all face unprecedented challenges as we face the impacts of a changing climate. These changes are fundamental, and will require a transformation to a much lower-carbon energy system. Meeting the climate challenge also will require a transformation in the ways we plan for the future and make decisions about infrastructure development. We can no longer rely on the past as a useful predictor of the future. Because our planning and governance systems are organized around discrete problems (e.g., water availability, air quality, land use planning), the challenges of climate change are especially difficult. Both the impacts and mitigation of climate change cross the boundaries that our planning processes treat separately.

Our capacity to plan and adapt to these overarching changes in our environment is currently limited. In order to effectively address the changes, uncertainty, and risk posed by climate change, we must enact fundamental changes that will transform our planning processes:

- First, we need to add the consideration of climate change as a key element in our current planning and decision-making processes.
- Second, we need to modify our planning and decision-making processes so that we conduct them on a holistic basis that considers multiple interconnected systems – as well as mitigation and adaptation – simultaneously.
- Third, we need develop dynamic planning and decision-making processes, with preparation and adaptation to change as a cornerstone.

Oregon is best served by this proactive strategy to build a planning framework that will ensure that our investments in infrastructure are sustainable within the context of an interconnected landscape of environmental change. Developing this framework will not only help ensure the health and robustness of both our economy and the natural environment, but it will provide significant opportunities for economic growth. Oregon is viewed as a leader in planning, and the knowledge and tools Oregon develops could serve as the basis for new businesses that provide similar services to other regions in the United States, as well as globally.

By meeting the climate challenge in a comprehensive way, we can ensure a sustainable, prosperous future for all Oregonians. The CCIG has developed a four-part report that provides a framework for meeting this challenge. These parts are 1) preparation and adaptation; 2) mitigation; 3) education and outreach; and 4) research.

CCIG Key Recommendations

Much information about climate change already exists that can be acted upon in rapid order. For example, we know that there are ample opportunities to increase energy efficiency in buildings. Capturing these savings would reduce emissions and produce cost savings. Water conservation can be increased among municipal, industrial and agricultural users. Efforts here would reduce the long-term costs of water procurement and management. Many other examples of readily available information exist that could be rapidly deployed to reduce emissions and prepare for climate change.

In this spirit, the CCIG recommends that Oregon move forward with the following key actions for addressing climate change. The Governor, the Legislature, the new Global Warming Commission, and state agencies should place these recommendations as one of their highest priorities. These recommendations fall within ten key themes:

1. Immediately Begin Preparing for Climate Change

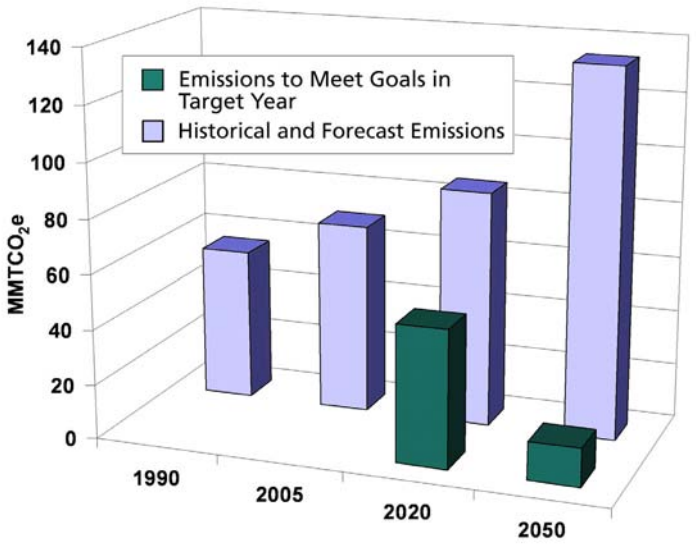
Even if greenhouse gas emissions are rapidly reduced, the long time scales of the Earth's ocean systems will cause global temperatures and sea levels to continue to rise over the next century. Oregon, like many regions of the world, is vulnerable to the effects of global climate change, which makes it imperative for the state to rapidly prepare for the coming effects of warming. Planning now for a different and uncertain future can benefit the present in many ways. Thinking strategically now about future risks posed by climate change can reduce those risks and also produce future benefits, for example, by building infrastructure such as expanding water supply or storm treatment facilities now rather than more expensively in the future.

- ➔ Prioritize increasing resiliency within Oregon's natural, built, human and economic systems before major impacts occur.
- ➔ Require and encourage all government agencies to adopt and implement climate change preparation plans.
- ➔ Assess existing capacity and develop governance systems appropriate for the rate and scale of change that will accompany climate change.
- ➔ Assess existing finance mechanisms and develop new funding options as needed to account for the longer time frames required to effectively prepare for climate change.
- ➔ Limit non-climate stresses on Oregon's natural, built, human and economic systems.

2. Act Now to Expand, Enhance, and Reinvigorate Mitigation Efforts

To address climate change, Oregon must move towards a largely carbon-free economy. In order to meet the State's 2020 emissions goal, we must reduce emissions by 42 percent from forecasted business-as-usual levels (see Figure 1). Since electricity and transportation are the largest sources of our state's emissions, this means we need a dramatic increase in the rate at which we implement energy efficiency and non-carbon-based energy sources, and to develop a less carbon-intensive transportation system. This report will later show that it appears that Oregon is on its way to stabilizing greenhouse gas emissions by the year 2010, the first of the State's greenhouse gas goals. However, the actions that have been put in place, as well as those that are in progress, will only achieve about one half of the necessary reductions to meet the 2020 goal. We have made significant progress, but much remains to be done.

Figure 1: Emission Goals Relative to Forecasted Emissions



- ➔ Enact a cap and trade regime for greenhouse gas emissions, in concert with other states and provinces in the Western Climate Initiative.
- ➔ Ensure that energy efficiency goals articulated in the 2004 *Oregon Strategy* are met.
- ➔ Take action to ensure that the tailpipe emissions standards adopted by the State can go into effect.[6]
- ➔ Take action to transform our transportation and land use planning processes to reduce greenhouse gas emissions.

3. Determine How Climate Change Will Affect Oregon's Diverse Regions

Although we already have useful information that can be acted upon, additional information in the hands of decision-makers is essential if we are to successfully address climate change. We must collect new information and develop new analytic tools in order to most effectively enact a response. Localized climate projections for the various regions within Oregon must be developed, and these localized assessments are essential for both the public and private sectors to respond to climate change. Information, practical research, analytical tools, and analyses must focus on helping Oregonians understand their

[6] At the time of this report, Oregon's adoption of California's tailpipe standards has been put on hold, along with similar action in over a dozen other states, by the U.S. EPA's refusal to let California go forward with the standards.

potential contributions to mitigation, as well as to understand the pressures that a changing climate will place on them and the actions that they can take to prepare for and adapt to climate change.

- ➔ Develop localized climate change assessments that focus on impacts of a changing climate, adaptation and preparation needs, and mitigation opportunities.

4. Assist Oregon Institutions and Individuals in Responding to Climate Change

Oregon needs to develop the institutional infrastructure to provide actionable information to help Oregon's institutions and individuals understand and act on the opportunities for both mitigation of and adaptation and preparation for climate change. Most public and private entities and households do not currently have the capacity or the expertise to complete vulnerability assessments or develop preparation policies and plans. Nor do existing academic, government, non-profit or private research, monitoring, or decision-making bodies currently have the capacity to plan, prepare or respond effectively to climate change. Recent flooding in the Northwest again has demonstrated how difficult it is to plan "outside the box."

- ➔ Lead by example by integrating systems-based planning for mitigation, adaptation, and preparation into state agencies' long-range processes that affect the development of physical infrastructure.
- ➔ Support integrated local government planning for both greenhouse gas mitigation and climate change preparation and adaptation.
- ➔ Develop the support and information infrastructure necessary for assisting business and industry in Oregon with climate change preparation and adaptation planning.

5. Develop and Implement an Education and Outreach Program

The Climate Change Integration Group was charged with the development of a climate change information and outreach plan. However, due to the interim nature of the CCIG, CCIG members believe it is best suited to provide the Global Warming Commission with a general roadmap for education and outreach. The Commission, as the permanent stakeholder body, will pick up the ongoing coordination of global warming policies and activities in the state and be responsible for designing its outreach and education program.

- ➔ Develop and implement a coordinated education and outreach program that will help increase public awareness of climate change impacts, strategies and benefits.

6. Transform Our Planning Processes to Deal with Climate Change

At all levels of government, we need to 1) consider climate change as a key element in our current planning processes; 2) modify our planning processes so that we conduct them on a holistic basis that considers multiple interconnected systems – as well as mitigation, adaptation, and preparation – simultaneously; and 3) develop dynamic planning processes that are designed to handle changing rather than stable conditions, and that continually observe, understand, and adapt to change. It is especially important that we enact these changes for transportation and land use planning, as decisions in these arenas have significant impacts on energy use, emissions, and the robustness of infrastructure.

- ➔ Ask that the "Big Look" Task Force explicitly address climate change as a core issue in land-use planning.
- ➔ Incorporate climate change effects and impacts into new transportation initiatives.
- ➔ Redesign planning tools to account for the future impacts of climate change.
- ➔ Use and continually improve adaptive management processes and contingency planning.
- ➔ Plan at larger scales to ensure that climate preparation in one sector or region does not affect preparation elsewhere.

7. View Responding to Climate Change as an Economic Development Opportunity

Responding to climate change will cause large amounts of capital to flow into both low-carbon technology and adaptation technology. Oregon should view this transition as an economic development opportunity. By choosing to act now, Oregon can create a business environment that stimulates and supports both mitigation and adaptation technologies. As early adopters, Oregon businesses can earn critical early market share. This can drive economic growth in the state and will establish a foundation for exporting both products and expertise to other states and the rest of the world. Oregon is well-suited to assume a leadership position in this transformation in our economy. The state has a long history of a conservation ethic and its public and private institutions are well-known for its leading edge work on sustainability.

- ➔ Build on the state's leadership in carbon offsets resulting from the Oregon Carbon Dioxide Standard, the nation's first greenhouse gas mitigation legislation.
- ➔ Build on Oregon's experience with managing forests by ensuring that forest carbon sequestration is acknowledged in state, regional, and national climate policy.
- ➔ Build on Oregon's leadership in green building by ensuring that a whole buildings perspective is accommodated by state, regional, and national climate policies.
- ➔ Link climate preparation to the existing economy and to new economic development efforts.

8. Incorporate the Public Health Implications of Climate Change

The impacts and implications of climate change on public health have been noticeably lacking in local, state, and federal policy on climate change to date. Given the potential magnitude of these issues, the prior inattention to this important area should be remedied in future policy.

- ➔ Integrate the public health impacts of climate change into the policy, planning, and preparation for climate change done by the Global Warming Commission, the state, and the research sector.
- ➔ Recognize and incorporate the benefits to public health of many climate change mitigation, preparation, and adaptation activities.
- ➔ Watch for unintended public health consequences of climate change mitigation, adaptation, and preparation activities.

9. Continue to Develop and Refine a Climate Change Research Agenda for Oregon

The CCIG has endeavored to develop suggestions for a research agenda on climate change for the Oregon University System and, to a lesser degree, for state agencies and the private sector. Research is a vital component of the framework Oregon needs to develop to assist individuals, businesses and governments to incorporate climate change into their planning processes. In addition, it is now clear that equal attention has to be given to the human dimension of climate change processes. It is clear that the newly created Oregon Climate Change Research Institute (OCCRI) must work with the new Global Warming Commission to address research needs.

- ➔ Create a Climate Change Research Working Group to advise the OCCRI so it can design and conduct a workshop of university researchers alongside business and community leaders to help develop a research agenda for Oregon.
- ➔ Coordinate research agendas across states and regions to avoid redundancy.

10. Provide Funding for Key Action Areas Identified In This Report

The importance of adequately funding a multi-track strategy cannot be overstated. State and local decision-makers will need to marshal financial investments commensurate with the scale of climate change and the risks it presents to Oregon's economy, citizens, and natural environment. Key areas for immediate funding identified by the CCIG in their deliberations are listed below.

- ➔ Allocate funding for multi-disciplinary and multi-county regional teams to develop and advance regional adaptation and preparation agendas, as well as potential regional mitigation strategies.
- ➔ Allocate funding for education and outreach activities in the range of $100,000.
- ➔ Provide additional funding for OCCRI in the range of $800,000 per biennium.

Introduction to Framework Elements

The record of Earth's climate is one of constant change on a wide range of time scales, such as the shrinking and expansion of the polar ice caps over tens of thousands of years, decadal scale drought cycles in the desert Southwest, and year to year variations in coastal ocean upwelling. However, human activities (primarily through the use of fossil fuels) are now beginning to force the Earth's climate beyond the range of natural variability that has been experienced over the past several hundred thousand years. With the increased level of global interdependency of our economy and our high level of dependence on technology, localized disruptions can have enormous and sometimes unexpected impacts on Oregon.

For example, Hurricane Katrina is estimated to have caused the permanent displacement of over 200,000 people, some of whom relocated to the Pacific Northwest. If such destructive storms continue to displace more people, this could have serious impacts on many regions of the country, just as the Dust Bowl did in the first part of the 20th century. Scientists also recently documented a link between increased rainfall in the northern Hemisphere with climate change, which may explain the summer flooding in parts of the U.S. and England.

Past episodes of climate variability have generally been limited regionally or of short duration. For example, shifts in atmospheric and ocean circulation result in a phenomenon known as the Pacific Decadal Oscillation (PDO). The PDO causes long-term oscillations in salmon populations, but from an economic perspective shifts in management and harvesting strategies can be implemented to accommodate times of low populations. The challenge now, however, is that we appear to be entering a period of more persistent shifts as well as more frequent periods of extremes.

Although market-based economies thrive on (and require) some level of uncertainty, if situations become nearly unpredictable and chaotic, markets can become unstable. We may no longer be able to use past conditions to help us predict the future. In a sense, it is the difference between investing and gambling.

Changes in average climate conditions, as well as changes in the level of variability, will complicate all aspects of personal, business, and governmental planning. Managing risk in an increasingly uncertain environment is extremely difficult. There will be unexpected linkages that are difficult to reconcile because of conflicting values and needs.

For example, warmer winters may shift the peak in runoff to earlier in the spring, meaning less water available for salmon migration, crop irrigation, and power generation. Warmer summer temperatures would also shift electricity demand in both the Northwest and California, further exacerbating the difficult balancing act between these competing needs for water in the Columbia River hydroelectric system. Sea level rise is likely to erode beaches, flood low-lying areas, and increase the damage during storm surges. Changes in average growing season temperature will change the types of wine varietals that may be grown in Oregon, making some areas suitable for wine growing that presently only support less valuable

crops, while making some high value wine grapes such as Pinot Noir more difficult to grow. Changes in climate will affect public health, as patterns of communicable diseases and disease vectors in Oregon change; chronic disease risk factors like ambient pollen concentrations, the prevalence of smoke from forest fires and physical activity patterns are altered; and economic changes threaten communities and put some Oregonians at risk for family violence and suicide.

The CCIG, through this report, seeks to start development of a framework to assist individuals, businesses, and governments incorporate climate change into their planning processes. The framework will need to evolve as our understanding of climate change improves and as we identify potential linkages and risks. The guiding principles will be threefold:

- Reduce our carbon "footprint" through increased energy, water and materials efficiency and reliance on renewable energy sources, cap and trade policies and other approaches.
- Prepare for and build resilience in our natural, built, and human systems while managing risks that might have catastrophic or irreversible consequences.
- Capture the social and economic opportunities that climate change presents.

The framework must acknowledge that some degree of climate change is now inevitable, and that a sustainable economy, a sustainable environment and the protection of public health are not irreconcilable. Building a planning and decision-making process that can meet these needs is essential if Oregon is to not only respond to climate change, but to prosper.

Our ability to respond effectively and prosper during climate change will, in large part, depend on our approach. We can view climate change as a problem to be solved or as a dilemma that will require our continuing attention and response. Problem-solving often seeks to make something unpleasant go away, expecting that there is a "once and for all solution." Approaching issues as a dilemma recognizes that there is a continuing process of testing, adaptation, and revision. The vision is positive, focused on continual innovation. Oregonians can create new ways to design, produce, and deliver energy, food, and other goods and services, and to manage our landscapes that enhance the climate, natural environment, public health and our quality of life. Innovation in the context of climate change offer tremendous opportunity for Oregonians to enhance our economic and social systems if we orient ourselves this way.

In this overall context of a planning framework for climate change, the CCIG developed a four-part report. These parts are 1) Preparation and Adaptation, 2) Mitigation, 3) Education and Outreach, and 4) Research. The CCIG believes that climate change represents both risk and opportunity, and that there are solutions that will not only make Oregon more resilient, but will improve the public's health and our quality of life. By meeting these challenges in a comprehensive way, we can ensure a sustainable, prosperous, and healthy future for all Oregonians.

Preparation and Adaptation

1. Summary

Even if greenhouse gas emissions are rapidly reduced, the long time scales of the Earth's ocean systems will cause global temperatures and sea levels to continue to rise over the next century. Oregon, like many regions of the world, is vulnerable to the effects of global climate change, which makes it imperative for the state to rapidly prepare for the coming effects of warming. It is, therefore, vital to rapidly devise, test, fund and implement strategies and policies to prepare Oregon's ecosystems and biodiversity, built infrastructure, human services, and economic systems to adapt to climate change.

Planning now for a different and uncertain future can benefit the present in many ways. Thinking strategically now about future risks posed by climate change can reduce those risks and also produce future benefits, for example, by increasing energy and water efficiency now and reducing the need for additional supplies in the future; or building infrastructure such as storm treatment facilities that can handle extreme storm events now, rather than paying for the costs of repair and cleanup in the future.

A more effective dialog with the public regarding climate change must be coupled with understanding or information about specific regional or local impacts and the need for climate preparation. Most public institutions, private organizations, communities or households have yet to begin a systematic plan to identify and reduce their vulnerabilities and increase resiliency to these vulnerabilities.

Most public and private entities and households do not currently have the capacity or the expertise to complete vulnerability assessments or develop preparation policies and plans. Nor do existing academic, government, non-profit or private research, monitoring, or decision-making bodies currently have the capacity to plan, prepare or respond effectively to climate change. Recent flooding in the Northwest has again demonstrated how difficult it is to plan "outside the box."

Although climate change poses serious challenges to businesses and local economies, it also provides numerous benefits and opportunities. Oregon could secure and capture competitive advantage in many of these sectors, and enhance jobs and incomes as a result. Oregon and Oregonians should immediately begin preparing for climate change using the principles detailed in this section.

2. Context

Even if greenhouse gas emissions are rapidly reduced, long time lags in the Earth's atmospheric and oceanic systems will cause global temperatures and sea levels to continue to rise over the next century and longer. The Intergovernmental Panel on Climate Change (IPCC) notes in its 2007 assessment that the "commitment" to future climate change may also involve unforeseen feedbacks to other components of the climate

system. Oregon is exceptionally vulnerable to the effects of climate change because its natural systems and much of the economy is dependent on water. Climate change is likely to bring significant changes to Oregon's water resources. Snow pack, for example, is already down an average of about 30 percent and spring runoff comes earlier, leaving lower flows in summer months. Lower stream flows affect agriculture, municipal water systems, fish and wildlife, water-based recreation, and summer hydropower sales.

Combined with projected population growth and regional differences in water availability due to geological factors, Oregon faces a severe resource allocation problem that will challenge the whole system of water rights. Lower flows also increase the likelihood of water quality problems. In addition, warmer temperatures and drier soils combine to raise the risk of forest and rangeland fires. Assuming similar patterns and statistical relationships hold in the future, as was seen in the later part of the last century, acres burned in Oregon are projected to increase 50 percent by the 2020s and by as much as 100 percent by the 2040s. As a result, the Oregon Department of Forestry could see its proportionate direct costs for fire control increase to $60-96 million by the 2020s and to $80-128 million by the 2040s. Additional wildfire costs from lost timber value, lost recreation, and air pollution are likely to be much larger.

Doug Jones, USFS

Not only terrestrial systems are at risk from climate change. Marine systems also are in jeopardy. Storm surges and sea level rise will cause increasing erosion on the coast, potentially affecting beach sand, roads and other infrastructure, and property. Estuaries are likely to be affected by the incursion of more salt water caused by rising sea levels. Shifts in atmospheric circulation are likely to affect coastal ocean ecosystems and productivity. Many other economic, social and environmental impacts are likely as global temperatures rise. The frequency and severity of precipitation events is increasing; winter storms are coming earlier; and more precipitation falls as rain rather than snow. All of this leads to increased flooding, property damage, and mortality. Floodplains need to be updated, not based on the past, but based on future expectations of climate change. Severe storms will likely cause problems managing storm water with subsequent negative impacts on water quality and endangered species.

While it is imperative to take aggressive steps to resolve global warming by reducing greenhouse gas emissions, the effect of such actions will not be felt for 30 to 50 years. The impacts of climate change, however, are already evident and will be increasingly significant. It is, therefore, vital to rapidly devise, test, fund and implement strategies and policies to prepare Oregon's ecosystems, built infrastructure, human services, public health, and economic systems to withstand and adapt to climate change. Recent studies suggest that climatic and ecological changes caused by global warming are occurring more rapidly than previously projected by scientific models, and that specific trends such as arctic ice melt and ocean acidification are increasing. These rapid changes call into question the adequacy of existing public and private sector planning, monitoring and evaluation, communication, economic development, and governance systems. This underscores an urgent need to develop new models and strategies to help Oregonians prepare for and adapt to climate change. The new models and

strategies must expand the time frame and scales at which planning is done, increase the speed at which data is gathered, assessed and disseminated, include validation and monitoring, and improve the way and pace at which preparation and adaptation decisions are made at all levels of society. Climate preparation will therefore challenge Oregonians to innovate and develop expanded approaches to planning, implementation, research, monitoring, and governance in order to keep pace with the speed of change occurring due to climate influences.

The U.S. Government Accountability Office (GAO) in September 2007 admonished its principal land management agencies for not incorporating climate change preparation into their strategic plans and management actions, and for focusing on the short-term. Like the recommendations in this chapter, it based its findings on the views of scientists, economists, and resource managers. Similar conclusions apply to local, state and federal government agencies, as well as the private sector, non-profits and individuals in Oregon: few have yet to meaningfully incorporate climate change preparation into their plans and activities.

Planning now for what seems certain to be a very different future can benefit the present in many ways. For example, reducing energy, water and material consumption saves money now while increasing resiliency for future times in which energy prices are higher and shortages occur due to climate change. Local and state governments are on the front line of responses to emergencies. Thinking strategically now about future risks posed by climate change can reduce those risks and also produce future benefits.

3. Recommended Actions in 2004 Strategy and Status Report

The 2004 *Oregon Strategy for Greenhouse Gas Reductions* acknowledged that Oregonians "will be adapting to the effects of warming for several generations to come." This is because "under the most optimistic assumptions, CO_2 accumulations level off at between 450 and 550 parts per million by mid-century before effective mitigation…begins to reduce concentrations." It warned that, "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 report makes no specific recommendations regarding preparation except:

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.

As recommended by the Advisory Group, the CCIG has addressed current issues and challenges for preparation and adaptation, and these are described below. However, additional work is needed to develop action strategies around preparation and adaptation and it is expected that the successor group to the CCIG – the Global Warming Commission – will take up this challenge.

4. Current Issues and Challenges

4.1 Lack of Public Awareness of Risks

Increasing public awareness of climate change has not been coupled with understanding or information about specific regional or local impacts and the need for climate preparation. Nor have many public

institutions, private organizations, communities or households begun a systematic plan to identify and reduce their vulnerabilities and increase resiliency to these vulnerabilities. Yet climate impacts are likely to grow over the next half-century regardless of the success of international efforts to reduce greenhouse gas emissions. While efforts are underway to reduce greenhouse gas emissions through energy efficiency and renewable projects, few attempts have been made in the state to analyze vulnerabilities and develop plans and policies to increase resiliency and reduce those vulnerabilities for human, built, and natural systems.[7]

Plans for preparation and adaptation to climate change are greatly complicated by continuing scientific uncertainty on the course of climate change and its impacts on regional and decadal scales. Moreover, organizations and people are more concerned about complex questions regarding the interaction of society and economies with climate change, rather than relatively straightforward questions of large-scale changes in snow cover. But changes in snow cover do affect municipal, industrial, and agricultural water supplies, the hydroelectric system, recreation, and tourism. While some preparation investments may be difficult to justify, business and governments frequently make investments under conditions of uncertainty.

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4.2 Lack of Capacity to Design Preparation Plans

Specific threats to the human and natural environment in the snow melt-dependent portions of our state and the likelihood of increased drought, wildfires, storm events, floods, sea level rise, biological invasions, species extinctions, and new disease pathogens affecting human, animal and plant health have not been met with effective capacity building within government or the private sector. Most public and private entities and households do not currently have the capacity or the expertise to complete vulnerability assessments or develop preparation policies and plans. Nor do many existing academic, government, non-profit or private research, monitoring, or decision-making bodies currently have the capacity to plan, prepare or respond effectively to climate change. New research and monitoring paradigms, adaptive planning, and governance mechanisms will be needed at the local, state, regional, and federal levels to incorporate and respond in a timely way to rapidly changing climate impacts. Where capacity and expertise exists, state agencies can build on these programs and the knowledge-base.

4.3 Gaps in Oregon's Public Health System

The lack of state investment in Oregon's public health system has made it difficult for public health agencies to carry out their core functions of detecting and characterizing health threats created from or worsened by climate change and mounting effective responses. Oregon's investment in public health is among the lowest in the U.S., and local governments, struggling with lack of revenue, have not been able to fill the gap. Enhancing the public health system's ability to respond to climate change-related threats will also yield collateral benefits in health protection in other areas.

[7] One recent attempt to increase awareness and begin a dialogue about preparation and adaptation for coastal community local government officials was a workshop held by the Oregon Coastal Management Program inOctober of 2007. The results of an informal survey taken during that workshop are informative as to the range of opinions and interests in preparation and adaptation strategies at the current time. See Appendix 6 for that survey.

4.4 Lack of Awareness of Climate Preparation Opportunities

Although climate change poses serious challenges to businesses and local economies, it also provides numerous opportunities. The global market for low carbon goods and services is expected to be $500 billion or more by 2050 because society will be seeking ways to reduce carbon emissions. Oregon is well-suited to capture competitive advantage in several of these sectors, and enhance jobs and incomes as a result. The demand for solar and wind energy technologies will grow, for example, and Oregon is well-positioned for some of these markets. In agriculture the need to adopt new crop varieties suitable to a changing climate may be a boon for early adopters. Climate refugees from high impact coastal or drought-stricken areas may enhance the work force and the economies that have the capacity to integrate them. Preparing for climate change is also likely to provide benefits to public health and other advantages that will not be inconsequential. Information about climate change should avoid purely pessimistic predictions and be framed around both risks and opportunities in a positive and accurate manner.

5. Findings

The Climate Leadership Initiative (CLI) at the University of Oregon, in partnership with the Governor's Climate Change Integration Group (CCIG), initiated a project to identify the key principles, strategies and policies that should guide climate preparation and adaptation in Oregon. CLI has organized the project into four interrelated tracks: natural systems (ecosystems and biodiversity), human services (hospitals, public health, emergency management), the built environment (buildings and public infrastructure), and economic systems (forest products, agriculture, high tech, and all others). The project began in the summer of 2007 with separate meetings involving people from the public, private, non-profit and academic sectors with expertise or knowledge important for the development of a framework for preparing and adapting to climate change in Oregon. More than eighty persons representing dozens of different public, private and non-profit organizations have participated in the development of these recommendations.

The groups came to the following conclusions about climate preparedness in Oregon:

- Climate change poses serious threats to the state's natural systems, built systems, the economy and human service systems. Because it is not possible to know in advance when significant impacts will occur, and because of the significant lead time typically required for major infrastructure changes, preparation planning within each of these sectors should begin as quickly as possible. A first step is to identify the key vulnerabilities and develop strategies to reduce those risks.
- Preparing for climate change offers both the private and public sectors several benefits. For example, reducing emissions will also improve air quality as well as public health. Increasing energy and water efficiency will provide Oregon's energy and water systems with increased capacity and resiliency while also saving money. Oregon companies can capture segments of growing markets in new products and services that will be needed to help people across the globe prepare for warming. Activities that produce co-benefits should be a high priority for preparation planning.
- While there is increasing awareness in both the public and the private sectors of the potential impacts of climate change in the state, few public or private organizations are developing formalized strategies and plans for reducing vulnerability to these impacts and increasing resiliency.

- Federal, state and local governments have a primary responsibility to prepare for climate change by ensuring continuity of services in public health and safety, emergency response, critical aspects of built infrastructure including communication, transportation, energy and water systems, and the ecological processes and systems that everyone depends on for sustenance.
- The public's need for information about climate change impacts, as well as preparation and adaptation strategies and their costs and benefits, is a paramount governmental responsibility that will require significant investments in new planning, rapid response data gathering and dissemination, and communication systems.
- Professional organizations and trade associations also have a paramount responsibility for communicating information about the risks and opportunities posed by climate change and assisting their members to develop and implement climate preparation plans.
- Existing financing mechanisms applicable to climate preparation may not be adequate to support the range of actions needed to prepare and continually adapt natural, built, human and economic systems to climate change.
- Every private company and household in Oregon should consider preparing now for climate change impacts. The state can play a key role in facilitating information and technology transfer to assists businesses, land owners, and homeowners in how to prepare.

6. Recommended Actions

Based on the outcomes of the CLI processes and other research, the CCIG recommends the following principles to guide the new Global Warming Commission and efforts across the state in preparing Oregon for climate change:

6.1 Prevention should be the first priority

Climate preparation should seek to prevent impacts by assessing potential vulnerabilities to natural, built, economic and human systems and developing plans and policies to increase resiliency before major impacts occur to the most vulnerable components of these systems. Prevention will be much less costly than repairing damaged systems and structures after impacts occur. Prevention is also directly linked with emission reduction because reducing the underlying causes of global climate change will mean less preparation is required.

6.2 Prioritize the most vulnerable

Climate change will affect everyone, but people and communities with more resources and capacity will be better able to withstand the impacts than people that are already under stress or are disadvantaged. Developing preparation plans now will build resiliency and reduce the vulnerability of these groups most at risk. In the natural world, endangered species and species already under stress from development and other non-climate factors are likely to be at greatest risk from climate change and will often require special attention. Roads, water systems and other infrastructure that are already worn or overcapacity are likely to be most vulnerable to climate impacts. Repairing or upgrading critical infrastructure that is already at risk should be a priority.

6.3 All government agencies should adopt preparation plans

State and local agencies should meaningfully incorporate projected climate change impacts and preparation planning into all of their existing programs and policies. For example, state agencies should integrate

climate change preparation into existing sustainability plans, agency risk management plans, or other long-range plans. Preparation plans should include contingencies due to the uncertainties about the intensity and timing of impacts.

6.4 Redesign planning tools

Traditional planning projects the future by looking backward at historical trends. For example, when engineers build structures that deal with water, like bridges and culverts, they use a statistical analysis of past trends. These trends may no longer represent future events as storms become more frequent and more intense. Traditional planning also usually takes into account only short-term (1-10 year) factors that may influence an organization or region. Climate change means, however, that the future will not look like the past and environmental changes will continue to speed up in the future. Climate preparation planning should occur at long time intervals, 10-25 and even 50-75-year scales, especially if major investments are being made in infrastructure that are expected to last more than 10 years.

6.5 Plan at larger scales to ensure that climate preparation in one sector or region does not affect preparation elsewhere

Efforts to increase resiliency to climate impacts within one sector or region must be carefully meshed with similar efforts underway within other sectors and regions if they are to succeed. For example, municipal water storage for resistance and resilience to cope with drought may negatively impact aquifers used for agriculture or fish. Positive benefits may also result from such integration. For example, preparation efforts within forestry and agriculture must be linked with natural system preparation efforts. In many cases achieving this integration will require planning at much larger scales than is currently done. We need to strengthen our approaches to integrated, system-wide planning. We continue to do such planning in a stove-piped manner, without examining impacts on sectors outside our sphere of interest. For example, armoring beaches changes sand transport and wave intensity which can have negative consequences on the adjacent shoreline.

6.6 Link climate preparation to the existing economy and to new economic development efforts

Following from the previous principle, climate preparation measures, existing economic activities, and new economic development efforts must be carefully linked to ensure that one does not undermine the other. For example, carbon sequestration policies may provide incentives to farmers to use no-till cultivation, and to foresters to conserve standing timber. New crop varieties more suitable to warmer temperatures and drier climates may save water and allow more water to be left instream for fish, while reducing pumping costs and providing more economic stability.

6.7 Limit non-climate stresses

Climate change is occurring at a time when many other stresses already affect Oregon's natural, built, human and economic systems. For example, habitat loss and fragmentation, low summer water flows, overfishing, and invasive species already threaten many species in Oregon. Climate change is likely to exacerbate these stresses, for example, by reducing summer stream flows even further, or causing more flooding events due to greater rain-on-snow events coupled with land-use practices that create erosion prone slopes. Similar dynamics exist in built, human and economic systems. Many of these stresses can be controlled at the state and local level, even if global climate change cannot. Land-use codes, for example, can be used and improved to discourage occupancy in flood, fire, or landslide hazard areas. Insurance premiums should be aligned with hazard risk and businesses should adopt a risk-management approach.

Preparation measures should be rewarded. Planners and managers should identify and implement methods for increasing climate resilience by reducing the locally produced stresses.

6.8 Use and continually improve adaptive management processes and contingency planning

The speed at which climate change is occurring and the uncertainty of the exact nature or timing of the impacts means that a flexible and responsive approach to climate preparation will be needed. The effectiveness of various preparation methods should be continually analyzed and approaches adjusted as new information becomes available.

6.9 Assess existing capacity and develop governance systems appropriate for the rate and scale of change

Given the rapid rate at which climate change may affect the state, Oregon's existing governance systems, including formal decision-making bodies such as the state legislature, commissions, city councils and county commissions will likely need to consider ways to speed up the rate at which information is considered and decisions are made. In addition, new forms of governance should be considered, especially at the local and regional scales. Watershed councils, for example, were a new form of governance developed in the early 1990s to facilitate watershed planning and management. Similar types of new governance mechanisms may be needed to plan, prepare for, and adapt to climate impacts at the local, eco-region and broader levels.

6.10 Assess existing finance mechanisms and develop new funding options as needed

Connected to assessing governance systems (6.9) is the need to analyze the finance mechanisms available for climate preparation. Because longer time frames and wider planning and management boundaries may be needed to effectively prepare for climate change, new financing mechanisms may be needed at the public and private levels. The group involved with the CLI human services preparation planning project, for example, advocated a state rainy day fund to provide emergency response for anticipated extreme flood and fire events. Other experts suggested that carbon emission penalties might be appropriately applied as a funding source for preparation measures, under the polluter-pays principle.

6.11 Coordinate research agendas across states and regions

Academic institutions, including the new Oregon Climate Change Research Institute, as well as federal, state, local, and private research efforts, should be meaningfully coordinated to identify priority data needs, and avoid unneeded costs and redundancy in data collection. Impact data should be scaled down to local and eco-region levels. Climate change observation and monitoring systems should be developed that track local trends in temperature, precipitation, ecosystem integrity indicators, new disease pathogens, and other climate change-related health outcomes.

7 Additional Actions

Several specific actions should follow from the findings, principles and data gaps. For natural systems, for example, existing habitat reserves may need to be examined for their effectiveness and new ones established, along with expanded migration corridors to facilitate species migration due to changing climatic conditions. Upgrades to building codes to reinforce new buildings against extreme weather events, providing better public information on climate-related health threats, and experimenting with new agricultural crop varieties better suited to a changing climate are other examples. The limitations of existing tools and measures to protect ecosystems, buildings, public infrastructure, human services and economic sectors in a new climate will require investigation along with the data gaps identified by the four groups that are included in the research chapter of this report.

Mitigation

1. Summary

In December 2004 the Governor's Advisory Group on Global Warming presented the *Oregon Strategy for Greenhouse Gas Reductions* to the Governor. That report provided an ambitious agenda of mitigation actions for the state to pursue. In addition, it proposed emission reduction goals for 2020 and 2050. These goals were adopted by the Legislature in the 2007 session. The CCIG has examined to what extent progress on these actions has brought us closer to the state's greenhouse gas reduction goals. The CCIG also worked to identify additional high priority mitigation opportunities that were not addressed in detail by the 2004 report.

Given that implementation of those actions is still at such an early stage, CCIG members focused on five areas for comment:

1. The CCIG recommends that greater attention be paid to transportation and land use policy, including detailed recommendations contained in this report in part 7 of this chapter.
2. The CCIG members urge a redoubling of efforts toward completing measures identified in the 2004 Oregon Strategy that have either not seen sufficient progress or have not yet been implemented – with special priority placed on energy efficiency measures.
3. The CCIG recommends that the State add a "whole building" component to maximize opportunities in the buildings sector.
4. The CCIG urges the State to ensure that the vehicle tailpipe standards recommended in the Oregon Strategy and adopted by the State can go into effect.
5. The CCIG recommends the State enact a cap and trade regime for greenhouse gas emissions, in concert with states and provinces in the Western Climate Initiative.

The cumulative emission reductions expected from actions from the 2004 *Oregon Strategy* and now in place (through legislation or other policy) and actions in progress (i.e., partially in place or partially completed) are charted in Figure 2 later in this chapter. In short, this figure indicates that Oregon appears to be on its way to stabilizing greenhouse gas emissions by the year 2010, the first of the State's greenhouse gas goals. However, it is also clear that even if Oregon completes all the actions that are "in progress" today, those actions – in combination with the actions that are in place today – will only achieve about half the necessary reductions to meet the 2020 goal. Moreover, future emissions growth will likely swamp the near-term gains of the actions recently put in place unless those actions are strengthened over time to compensate and additional actions – beyond those identified in the *Oregon Strategy* – are taken in the future.

2. Context

In December 2004, the Governor's Advisory Group on Global Warming presented the *Oregon Strategy for Greenhouse Gas Reductions* to Governor Ted Kulongoski. The goals recommended by the *Oregon Strategy* were based on the best available scientific studies on the unintentional build-up of greenhouse gases in the atmosphere, the current and future effects of these gases, and benefits of reducing future emissions. The actions recommended by the *Oregon Strategy* were based on technologies and policies that were either currently available or emerging.

The development of the *Oregon Strategy's* goals and actions was guided by a set of principles adopted by the Global Warming Advisory Group. These principles took a wide range of factors into account: basing the *Oregon Strategy* on science; placing a priority on the most cost-effective solutions; maximizing our economic well-being while achieving climate stabilization; stimulating low-carbon innovations while building on Oregon's leadership in sustainability as a key focus of economic development; taking action commensurate with Oregon's share of the problem by working in concert with other states; recognizing and accommodating the competitiveness needs of Oregon business, preserving energy reliability, and equitably allocating costs and benefits. This report from the Climate Change Integration Group reaffirms these principles. The full set of principles appears in Appendix 5.

2.1 Co-Benefits to Climate Change Mitigation

Actions that reduce or sequester greenhouse gas emissions solve a wide variety of environmental, health, economic and political problems in addition to mitigating climate change.

2.1.1 Environmental

- **Biodiversity protection.** Land-use change, mostly in the form of deforestation, is responsible for 18.2 percent of global greenhouse gas emissions.[8] Deforestation and associated habitat loss are currently causing the most rapid mass extinction of life ever recorded over the earth's 4.6 billion years.[9] Reforestation, therefore, has the potential to mitigate both climate change and a biodiversity crisis.
- **Resource preservation.** Mitigating climate change requires using fewer resources. Mining, smelting, refining – all the elements of resource extraction – are energy intensive and will, therefore, be minimized in a carbon-constrained world. Likewise, water resources often can be extended through practices that also cut energy use. Mitigating climate change, therefore, promotes using the resources we have extracted efficiently and intelligently. This protects not only the climate, but also leads to fewer environmentally destructive mining and industrial processes.

2.1.2 Health

- **Reduction in local and regional air pollutants.** Combusting fossil fuel emits CO_2 and other local and regional air pollutants, including sulfur dioxide, ozone and particulate matter. Mitigating climate change requires combusting fewer fossil fuels, resulting in people breathing fewer of these local and regional pollutants, which can trigger asthma attacks and other lung and heart problems.

[8] Baumert, Kevin, Timothy Herzog, Jonathan Pershing. 2005. Navigating the Numbers: Greenhouse Gas Data and International Climate Policy. Washington, D.C.: The World Resource Institute.

[9] Thomas, J.A. et al. 2004. Comparative Losses of British Butterflies, Birds and Plants and the Global Extinction Crisis. *Science* 303:1879-1881.

- **Increased use of public transportation.** Lack of physical activity is a major contributor to obesity and other adverse health outcomes. Because using public transportation requires walking to or from transit stops, increasing public transportation use can substantially increase daily physical activity.

2.1.3 Economic/Political

- **Energy Security.** Mitigating climate change requires weaning ourselves off of fossil fuels. There is no silver bullet energy source which can take their place. Instead, fossil fuels will be replaced by a diversity of different energy options which can be produced within the United States. This substitution will come at a time when the U.S. is becoming increasingly dependent on the Middle East to meet its energy needs.
- **Cost Savings.** Mitigating climate change will require significant advances in the efficiency of our energy consumption. While break-through technologies will emerge in a carbon-constrained economy, considerable and immediate results can also be achieved today with off-the-shelf energy efficiency technologies that cut costs and pay for themselves.[10] This co-benefit is particularly important for low-income energy consumers, whose energy bills represent a large portion of their income, and also plays a role in keeping Oregon businesses competitive.

Bruce Sullivan

- **New Jobs.** Mitigating climate change requires creating a new clean energy industry to fuel transportation, building and industrial needs. This energy industry will require engineers and physicists, but also what Van Jones of the Ella Baker Center for Human Rights labels "green collar jobs" – workers to install solar panels, upgrade the efficiency of buildings, implement sustainable agriculture, etc.[11]

3. Recommended Actions in 2004 Strategy and Status Report

3.1 Status of Recommended Actions in the 2004 Oregon Strategy Report

The 2004 *Oregon Strategy for Greenhouse Gas Reductions* provided an ambitious agenda of mitigation action for the state and Oregonians to pursue. This section provides a brief summary and current status of those actions. Importantly, several key actions have now either been put in place or have been passed into law or regulation, allowing us to say with a degree of confidence that their impacts will carry forward through at least the year 2025. These actions, as well as their predicted emission reductions in the year 2025, are summarized in Table 3 on the following pages.

[10] A global study of the size and costs of measures to reduce greenhouse gas emissions found that 25% of reductions needed to meet the 450 ppm could be achieved by energy efficiency measures that paid for themselves. Source: "A Cost Curve for Greenhouse Gas Reductions," the McKinsey & Company, 2007.

[11] http://www.ellabakercenter.org

The vast majority of actions in the 2004 *Oregon Strategy for Greenhouse Gas Reductions* are neither established nor completely finished. Instead, many of these recommendations have seen some progress over the past several years, but are not at a point where we feel comfortable labeling them as having been completed or put in place. This fact is compounded by the fact that many of the original recommendations in the 2004 report were actually suites of recommendations – a single package of bulleted points addressing a range of areas within a topic. For this reason it is difficult to quantify the reductions involved with these recommendations, but they are instead packaged together as the "In Progress" actions remaining from the 2004 report. Table 4 on the following pages lists these actions and provides a status report on where they are if that information is available.

A small number of actions recommended in the 2004 *Oregon Strategy for Greenhouse Gas Reductions* report are addressed in some detail for the first time in this report. These actions are listed below in Table 1. By addressing these items in detail, the CCIG does not consider that these action items from 2004 are now complete. The opposite is clearly true. However, it is hoped that by fleshing out these recommendations in detail, additional progress can be made toward achieving these recommendations.

Table 1: Actions from 2004 *Oregon Strategy* Addressed in this Report

Action from 2004 Report	Summary of Action	Million Metric Tons of CO_2 equivalent ($MMTCO_2e$) by 2025
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.	
TRAN-2	Integrate land use and transportation decisions with greenhouse gas consequences.	0.40 (old estimate likely not valid with new recommendations made in this report)

Finally, it is difficult to say if any forward progress has been made on some actions from the 2004 *Oregon Strategy*. Table 4 below lists those actions where either nothing has happened, or where so little has progressed since 2004 that we are uncomfortable making forward projections on any emission reductions that may result from these programs or policies. Table 2 below lists those specific policies or actions from the 2004 *Oregon Strategy* where the actions described in that report have so far failed to materialize or give the appearance of having any forward momentum.

Table 2: Actions from 2004 *Oregon Strategy* Yet To Be Implemented

Action from 2004 Report	Summary of Action	MMTCO$_2$e by 2025
TRAN-7	Adopt state standards for high efficiency/low rolling resistance tires.	0.12
TRAN-10	Adopt state and local incentives for high efficiency vehicles.	unknown
BIOSEQ-2	Consider greenhouse gas effects in farm and forest land use decisions.	0.6
BIOSEQ-3	Increase forestation of under-producing lands.	0.5
BIOSEQ-6	Establish a municipal street tree restoration program.	less than 0.1
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
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
MW-7	Change land use rules to allow commercial composting on land zoned High Value EFU (exclusive farm use).	less than 0.01
MW-8	Increase public awareness to discourage on-site burning of garbage, especially fossil-carbon materials.	0.02
MW-9	Continue landfill regulation with additional reporting and analysis.	unknown
MW-10	Evaluate methane emissions from closed landfills and options to reduce such emissions.	
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.	

Table 3: Key Actions Now in Place from *Oregon Strategy for Greenhouse Gas Reductions*

Action from 2004 Report	Summary of Action	MMT CO_2e 2025	Status/Background
IA-1	Recommend the Governor adopt near-term, intermediate and longterm greenhouse gas emissions goals for Oregon.		Greenhouse Gas Targets adopted by Legislature in 2007 session through the passage of HB 3543.
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.		Permanent advisory body on climate change issues established by 2007 Legislature through the passage of HB 3543
GEN-1	Increase the renewable content of electricity.	0.80	Many (if not most) actions identified in the Renewable Energy Action Plan (REAP) are on track, due in part to passage of recent energy legislation.
GEN-1a	Increase retail energy sales from renewable resources by one percent or more annually in Oregon through 2015.		Addressed by passage of Oregon's Renewable Portfolio Standard (RPS) in 2007 Session (SB 838). See GEN-2a.
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.	See 2004 report for details	Carbon Allocation Task Force appointed by the Governor finished work in January of 2007 and submitted median proposal to Governor. Median proposal was drafted as HG 3545 for the 2007 session. The bill did not make it out of committee, but work on carbon cap and trade continues as apart of Western Climate Initiative.
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.	7.0	A Renewable Portfolio Standard (RPS) was passed in the 2007 session (SB 838) that requires 25 percent of electricity sold by large utilities to be renewable by 2025 (with lesser targets for smaller utilities). Changes to the public purpose charge were also made.

GEN-3	Support the Oregon Public Utility Commission's review of rules and tariffs for renewable and combined heat and power facilities.	0.54	ODOE participated in OPUC proceedings to adopt standard tariffs and rates for renewable and CHP facilities under 10 MW. Those tariffs are in place.
EE-1b	Upgrade Oregon building codes to reduce energy use by at least 15 percent by 2015 (building shell measures).	0.52	A joint effort of the Oregon Building Codes Division and the Department of Energy is underway to reduce energy use by 15 percent in all new homes. As this report is being finalized, there are no apparent unresolved issues to delay adoption of this policy.
EE-1c	Amend building codes to set minimum space and water heating/cooling standards.	0.09	Residential and smaller commercial HVAC standards are established by the National Energy Policy Act. Oregon has upgraded the proposed residential energy code to meet new federal standards and is offering builders the choice to install more efficient HVAC equipment as a means to comply with code.
EE-1d	Adopt state appliance efficiency standards.	0.41	Oregon has passed legislation adopting minimum energy efficiency standards for 17 categories of appliances and equipment not regulated by the federal government. As a result of similar actions taken in about a dozen states, the federal government has subsequently adopted standards for five of the categories, and standards are pending for several more.
EE-1f	Support Oregon Public Utility Commission (OPUC) actions to evaluate NW Natural/ETO and ODOE natural gas incentive programs.	0.24-0.48	Completed. Both the Residential Energy Tax Credit (RETC) and the Business Energy Tax Credit (BETC) saw large increases in energy saved and renewable energy produced. There were increases across all fuels and program types with the sole exception of BETC electricity saved. Total energy saved and produced more than doubled between final certifications in 2005 and 2006. Energy from final certifications for 2007 will be substantially more than in 2006.

EE-1g	Advocate with OPUC for Avista and Cascade natural gas utilities to meet energy savings goals comparable to NW Natural.	0.05	Avista adopted a comparable program on October 12, 2006. Cascade adopted a comparable program on June 28, 2006. These are also operated by the Energy Trust of Oregon.
EE-1h	Advocate for federal equipment and appliance efficiency standards.	0.40	See EE-1d
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.		Completed. Proposal resulted in completion of TRAN-1a and TRAN-1b below.
TRAN-1a	Adopt Low Emission Vehicle (LEV II) Emission Vehicle Standards.	0.24	The Oregon Environmental Quality Commission adopted California's Low Emission Vehicle rules (including "Pavley standards") to become effective with the 2009 Model Year.
TRAN-1b	Adopt greenhouse gas Tailpipe Emission Standards (per California AB 1493 "Pavley" standards).	>6.0	
TRAN-3	Promote biofuel use and production.	1.0	The 2007 Legislature passed HB 2210 to expand property tax incentives for biofuels, establish a new tax credit for producers and collectors of biofuel raw materials and create an income tax credit for consumer use of biofuel. It also establishes a Renewable Fuel Standard (RFS) for biodiesel and ethanol based on meeting a threshold of in-state production.
BIOSEQ-5	Leverage the Conservation Reserve Program to expand reserved acreage.	0.2	Most eligible highly erodible lands are now enrolled in the program. With present rental rates for CRP and the program cap limits, there probably won't be much more enticement to enroll more acres in Oregon unless rental rates significantly increase or the program caps are adjusted, both of which are unlikely.
MW-6	Develop statewide recovery infrastructure for consumer electronics waste, with shared responsibility among producers, retailers, non-governmental organizations, and government.	0.03	2007 legislation created program; collections start 2009.

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.		State Agency Inventory completed by DAS and OUS in 2007. Sustainability plan efforts around greenhouse gas mitigation are an ongoing activity in most agencies.
Total Reductions from Completed Actions ($MMTCO_2e$ in 2025): 17.76			

Table 4: Actions from 2004 *Oregon Strategy* That Are In Progress

Action from 2004 Report	Summary of Action	MMT CO_2e 2025	Status/Background
EE-1a	Expand and coordinate electric incentive programs for Investor-Owned Utilities (IOUs).	3.20	Residential and smaller commercial HVAC standards are established by the National Energy Policy Act (EPACT). We have upgraded the proposed residential energy code to meet new federal standards and are offering builders the choice to install more efficient HVAC equipment as a means to comply with code.
EE-1e	Advocate with Bonneville Power Administration (BPA) and Oregon electric consumer-owned utilities (COUs) to meet the NWPCC goal.	1.24	BPA and Oregon electric COUs have been working on new 20-year power-sale contracts. These contracts will likely place the responsibility for meeting load growth on the COUs. This will provide better incentives for Oregon COUs to actively pursue energy efficiency and renewable generation as their alternative would be wholesale power at market prices.
EE-1i	Strengthen state marketing of energy efficiency and incentive programs; initiate Governor's Awards.		Continuing activity of ODOE, OPUC, and other agencies. No progress on Governor's Awards concept.
EE-2	Support OPUC and COU efforts for modified rate designs to reflect daily and seasonal peak demand.	0.16	ODOE is working with OPUC and others to install advanced two-way communication meters for virtually all PGE customers over the next few years. This technology will facilitate rate designs to reduce peak demands. This proceeding should conclude in 2008.

EE-3	Support OPUC initiatives for natural gas and fuel switching.	0.10	High retail prices for natural gas have made the economics of fuel switching to natural gas more difficult. There has been no change in programs in this area.
GEN-4	Encourage state government to purchase renewables.	0.08	The Governor committed the state to using 100% renewable energy for state facilities if it proved to be feasible. Feasibility analysis is continuing.
GEN-5	Advocate for specific federal policies or legislation.	Varies	Normal activity of Governor's Office and agencies.
GEN-6	Advocate with BPA to support Oregon's renewable energy measure.	Varies	ODOE staff has participated in discussions about a new BPA service to integrate and firm intermittent renewable generation, such as wind.
TRAN-4	Review and enhance state tax credits and local incentives for citizens purchasing high efficiency vehicles.		Rules for tax credits have been improved to ensure that only true hybrid vehicles qualify. Change in tax credits to reflect mpg rather than technology would require new legislation.
TRAN-6	Expand "Transportation Choices Programs" and "Travel Smart Pilots."		ODOT has funded TravelSmart pilot in Salem, Bend, and Eugene. No station car funding exists. Carpool matching and online transit services expanded considerably.
TRAN-8	Reduce greenhouse gas emissions from government fleet purchase and vehicle use.		State fleet continues to purchase more hybrid vehicles and to pursue alternative fuel options. There is continued progress on incorporating efficiency into procurement practices.
TRAN-9	State and local governments should switch to "clean diesel" fuel, vehicle purchases and retrofits.	0.10	Waiting for response from DEQ Some progress known to occur.
TRAN-11	Set and meet goals for reduced truck idling at truck and safety stops.		Truck stop electrification project well underway, with first units installed. Overall goals have not been set for the project.
TRAN-12	Set up traffic flow engineering "Best Practices."	0.08	Signal coordination project underway. Ramp metering and other ITS strategies have been put in place throughout state. Variable speed limits and congestion pricing programs under consideration but not deployed.

TRAN-13	Set and meet goals for freight (truck/rail) transportation efficiency; achieve this through equipment, coordination and land use.		ConnectOregon I, approved in the 2005 session, has 40 projects under way. A second bill (ConnectOregon II) was successful in the 2007 Legislature, with 78 projects received. ConnectOregon II is on schedule for decisions by the Oregon Transportation Commission in June 2008. ODOT's revised guidelines to local jurisdictions on preparing their Transportation System Plans (TSPs) contain stronger guidance about land use planning for freight and industrial activities.
TRAN-14	Establish consumer awareness education link to transportation choices.		The Oregon Department of Transportation, Metro, TriMet, City of Vancouver and other public and private partners launched the Drive Less/Save More Campaign in February 2006. Other areas of recommendation have generally not been pursued.
TRAN-15	Improve mass transit and inter-city transit links.		In 2004 ODOT used flexible federal funds to initiate a small program to assist urban transit providers in replacing older mass transit vehicles. ODOT has Federal funds for rural and inter-city bus service to fund new or expanded service in Welches, Sandy, Yamhill County, Curry County, Linn County, Hood River, The Dalles, Columbia County and other areas of Oregon.
BIOSEQ- 1	Reduce wildfire risk by creating a market for woody biomass from forests.	3.2	Since 2004, 22 MW of biomass capacity have been put into operation with approximately 20% of this additional capacity using forest sourced thinnings (a reduction of 0.14 $MMTC0_2$). Oregon now has MOUs with federal forest managers for forest stewardship acreage guarantees. These MOUs address over 700,000 acres of forest over 30 years, and eliminate some 1 $MMTCO_2$ annually by reducing uncharacteristic crown and stand clearing wildfire.
BIOSEQ-4	Expand the application of water-erosion reducing practices for cereal production.	0.2	Research has shown that continuous winter wheat yields are generally not economically competitive with winter wheat after fallow. Low-till and no-till practices have proven more promising in some areas of Oregon. Wasco County is roughly 70 percent direct seeded.
MW-1	Achieve the waste generation (prevention) and recycling goals in statute.	5.2	Recycling goals close to being met; prevention goals are not, but new programs are under development.

MW-4	Provide incentives to increase salvage of reusable building materials.	0.02	Grants dispersed
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	2007 legislation added water bottles (in 2009) to bottle bill and formed a task force to study other issues
Reductions from Actions In Progress ($MMTCO_2e$ in 2025):			**13.63**

3.2 Progress in Meeting 2004 Oregon Strategy

The most important question involving the actions and measures from the 2004 *Oregon Strategy for Greenhouse Gas Reductions* is to what extent progress on these actions has brought us closer to the state's greenhouse gas reduction goals. A key figure from the 2004 *Oregon Strategy* report was what has become known as a "wedge" diagram that illustrated how a series of key measures (or groups of measures) would act in succession to slowly lower greenhouse gas emissions as a result of putting those policies in place.

Figure 2: Impact of Oregon Strategy Actions (from 2010) In Meeting Emission Goals

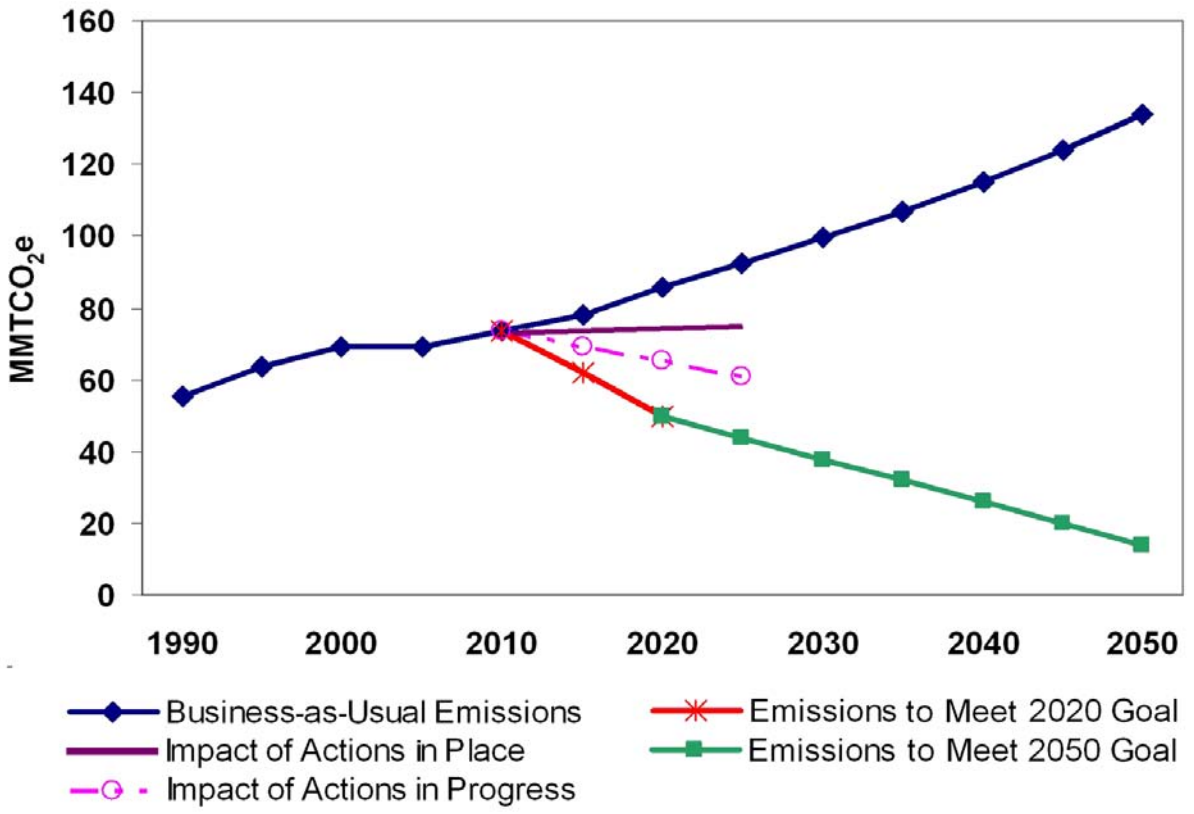


Figure 2 above demonstrates the likely impacts of actions currently in place through 2050. To establish a "business-as-usual" scenario for comparison, historical greenhouse gas emissions are included through

2005, and the greenhouse gas forecast contained in this report (through 2020) and an extrapolation of that forecast (through 2050) are plotted as the top emissions trajectory. Note that when comparing the two figures (from the original report and this report), the historical and forecast emissions are slightly different due to the updated emissions inventory in this report.

In order to gauge how Oregon compares to its first greenhouse gas reduction goal – to stabilize and begin reducing greenhouse gas emissions in 2010 – emission reduction scenarios are plotted relative to 2010 so that the slope of those emission trajectories can best demonstrate progress toward that goal. This overly simplifies the actual "real world" impacts of programs and policies that have been put in place since completion of the 2004 *Oregon Strategy for Greenhouse Gas Reductions*; but since the largest reduction policies and programs that have been put in place since that report (namely the RPS and vehicle tailpipe standards) don't begin until that time period, this simplification provides a reasonable approximation of actual emission impacts.

To gauge progress toward meeting the states' other two emission reduction goals in 2020 and 2050, a compliance baseline is plotted beginning in 2010 such that the 2020 goal is achieved, and then continuing from 2020 until 2050 such that the 2050 emissions reduction goal is achieved. The large gap between the high end of the "business-as-usual" scenario in 2050 and the goal compliance scenario in the same year demonstrates the substantial reductions necessary.

The cumulative emission reductions expected from actions that have been put in place (either through legislation or executive action) and that derived from the 2004 *Oregon Strategy* are charted in Figure 2 as the nearly flat line emanating from 2010 until 2025. These are the actions listed in Table 3 (Key Actions Now in Place) in the proceeding pages. As can be seen, this emissions trajectory indicates that Oregon would appear to be on its way to stabilizing greenhouse gas emissions by the year 2010, and thus achieving the first of the state's greenhouse gas goals.

However, it is likely that the emission "stabilization" achieved by 2025 through the policies currently in place will eventually be overcome as emissions growth continues. Thus, it is not realistic to assume that this "stabilization" (as represented by the nearly flat line in Figure 2) will continue past the mid-2020s time period, because the two key policies driving emissions downward until this point in time (the RPS and the vehicle tailpipe standards) will have achieved their maximum effectiveness. From roughly 2025 onwards they will provide a substantial reduction in emissions (at least that achieved in the year 2025), but it is likely that rising population, vehicle use, energy demand, and so forth will negate the emissions stabilization achieved in the 2025 time period. Thus, this nearly horizontal line should not be presumed to continue past the year 2025 in Figure 2, but a precise trajectory has not been modeled at this time. It should be noted, however, that both the RPS and the vehicle tailpipe standards could be "ramped up" as needed to maintain this emissions stabilization in the future, if so desired.

The third line, broken and slanting downwards from 2010 until 2025 (but no further), represents the potential emission reductions from actions that are "in progress" — assuming that those actions are fully completed (as described in the 2004 *Oregon Strategy* report) by the year 2025. These are the actions listed in Table 4 on the proceeding pages. Because of the substantial uncertainty as to how completely these actions will in fact be implemented by 2025, and the diverse nature of these "in progress" actions,

projecting their impact until 2050 (even on a rough basis as was done above) is not realistic. Nonetheless, the downward trend to 2025 is encouraging. However, it is also clear that by the year 2020 we only have enough policies and actions either in place or in progress to achieve roughly half the needed emission reductions to meet the 2020 goal. It is also clear that achieving the 2050 goal with actions in place or in progress will not occur. Clearly, additional actions and policies will be necessary if Oregon is to achieve its 2050 goal.

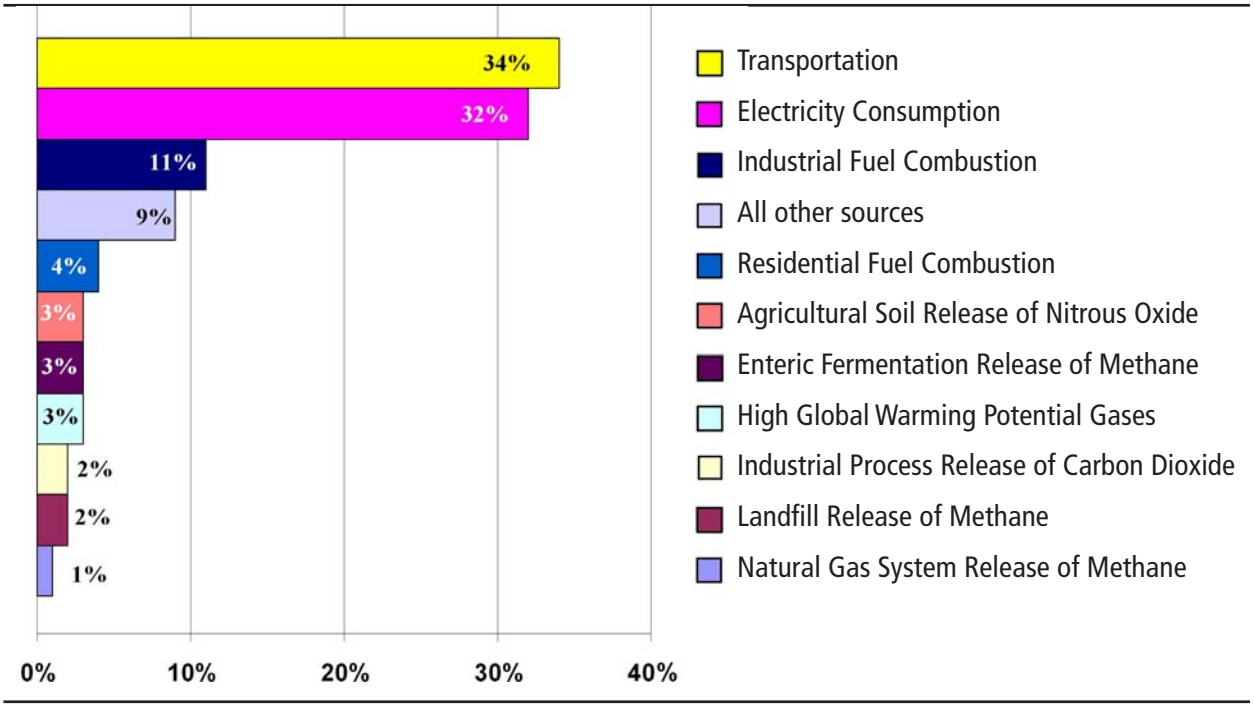
4. Current Issues and Challenges

In 2004, Oregon's greenhouse gas emissions totaled 67.5 million metric tons of carbon dioxide equivalent ($MMTCO_2e$).[12] This was about one percent of total U.S. emissions, which were around 7.1 billion metric tons of CO_2e.

Oregon's greenhouse gas emissions have grown by 22 percent from 1990 levels, which were 55.5 $MMTCO_2e$. Oregon emissions growth has been greater than that for the U.S. as a whole, which grew by 16 percent over the same time period.

The Oregon Department of Energy completed a revised and updated *Inventory and Forecast of Oregon's Greenhouse Gas Emissions* for the Climate Change Integration Group. It is attached as Appendix 1. The ten largest sources of emissions are summarized below in Figure 3. These are the ten sources that each comprise one percent or more of Oregon's overall emissions.

Figure 3: Major Sources of Greenhouse Gas Emissions in Oregon (2004)



[12] "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 timescale. Following U.S. 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 (newer IPCC GWPs are not used in this report).

Transportation (34%) and electricity (32%) clearly dominate Oregon's greenhouse gas footprint. These two, together with industrial fuel consumption (11%), constitute over three-fourths of Oregon's emissions.

Different parts of Oregon's economy contribute to these emissions. See Figure 4. When the electricity used by each sector is attributed to that sector, the transportation of goods and people (35%) again dominates, followed by the use of energy in buildings (30%), industrial and waste processes – and the facilities that house those processes (28%); much smaller in proportion is the use of livestock and fertilizers in the agricultural sector (7%).

It is also interesting to note how emissions have grown over time in different parts of Oregon's economy. Figure 5 to the right illustrates that the fastest growing segment of greenhouse gas emissions between 1990 and 2004 is in the building energy sector (although only residential and commercial buildings are combined here). However, emissions growth in the other sectors is also alarming, although agricultural emissions have remained more or less steady over this time period.

Oregon's emissions are projected to grow significantly between now and 2020. Anticipated emissions for 2020 are 85.7 $MMTCO_2e$, an increase of 27 percent. The majority (at least 70 percent) of this growth is expected to come from transportation and electricity use in buildings.

Figure 4: Economic Sector Contributions in 2004

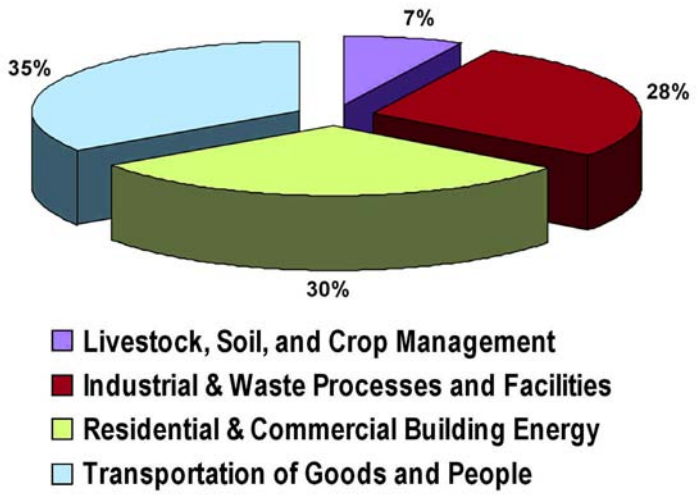
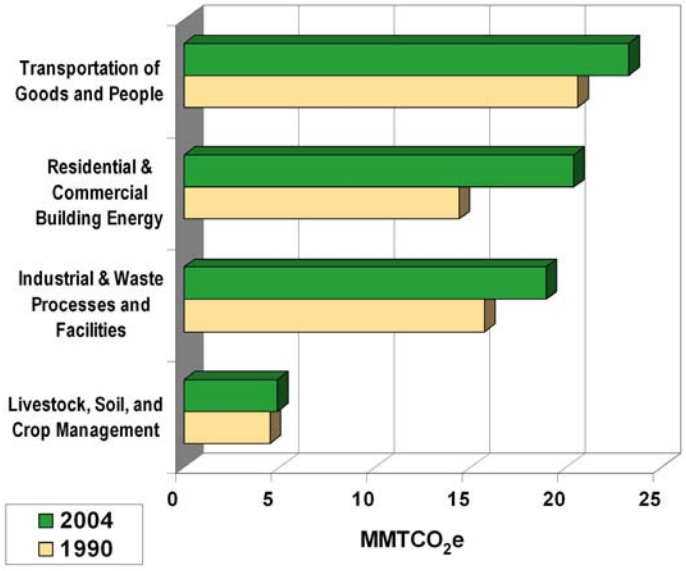


Figure 5: Growth of Sector Emissions from 1990 to 2004



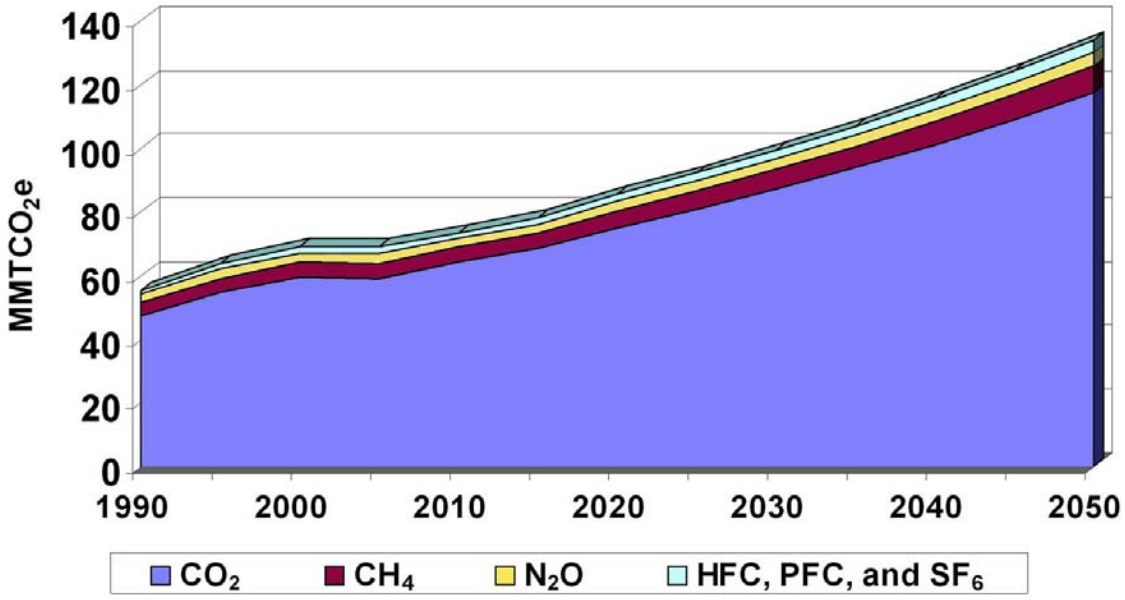
The state's formal forecast of emissions runs through 2020. The emissions growth rate from 2004 through 2020 is 1.5 percent per year. Extrapolating this growth rate for thirty more years yields year 2050 emissions of 134 $MMTCO_2e$ (see Figure 6). This business-as-usual extrapolation through mid-century means that emissions would be double those of 2004 levels.

The *Oregon Strategy* proposed the following goals for Oregon:

- Arrest growth through 2010.
- By 2020, achieve a 10 percent reduction below 1990 levels.
- By 2050, achieve a "climate stabilization" level of at least 75 percent below 1990 levels.

These goals were adopted by the Governor in 2005 and by the Legislature through the passage of HB 3543 in the 2007 legislative session.

Figure 6: Extrapolation of "Business-as-Usual" Greenhouse Gas Forecast Through 2050



Putting these reduction goals into the context of the business-as-usual forecasts for the state's emissions means that for 2020, the goal translates to 49.9 $MMTCO_2e$. This represents a reduction of 42 percent from the forecast level of 85.7 $MMTCO_2e$. For 2050, the goal translates to 13.9 $MMTCO_2e$. This represents a reduction of 90 percent from the forecast level of 134 $MMTCO_2e$. Figure 7 to the right provides an overview of these goals in the context of the forecasts and current and 1990 emissions levels. Thus, over the next 43 years, we must put into place a 90 percent carbon-free economy, in comparison to today's economy. And we must get almost half way there between now and 2020.

Figure 7: Historical and Forecast Emissions Relative to Reduction Goals

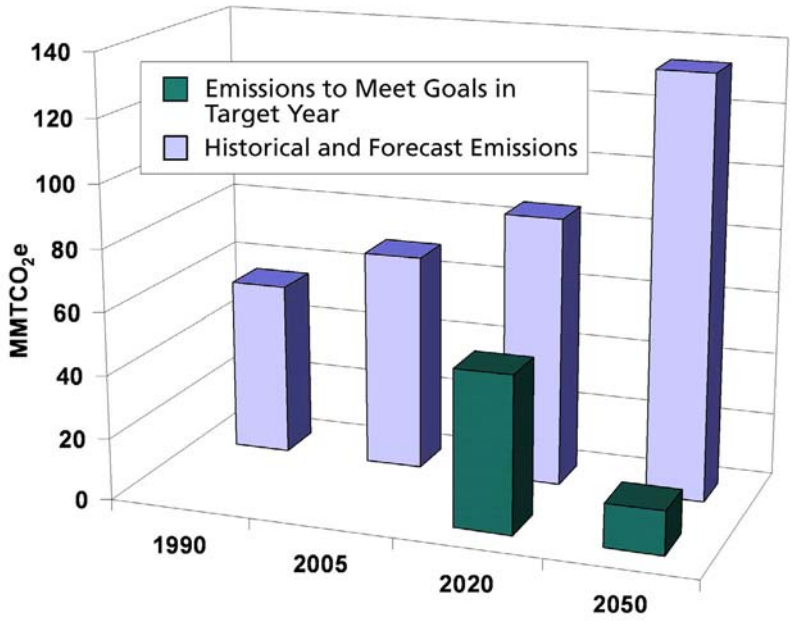
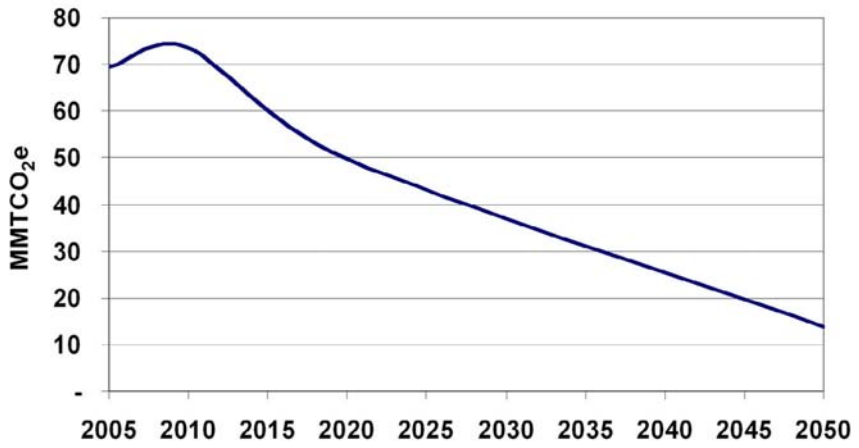


Figure 8 below presents a graph of the goals from 2005 through 2050. The total amount of emissions over this 45-year period is approximately 2,000 $MMTCO_2e$. We can think of this as our greenhouse gas "budget" over this time period.

If we do not achieve our targets in the near term, we will have to achieve greater reductions later in order to make it to the year 2050 within our budget.

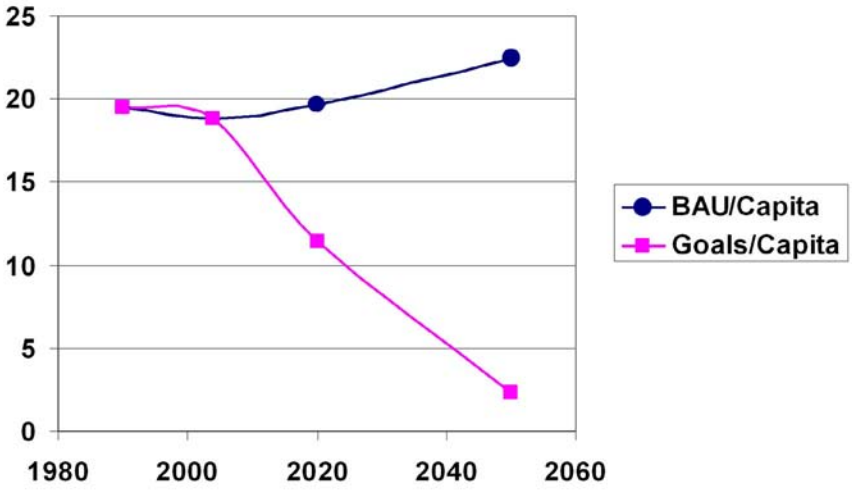
Figure 8: Greenhouse Gas "Budget" Based on Reduction Goals



Under the business-as-usual forecast through 2020, we would emit 1,163 $MMTCO_2e$, or 58 percent of the total budget. If we were to proceed on the business-as-usual course, we would have 837 $MMTCO_2e$ of our budget to last for the next thirty years (2020-2050). At that point, emissions would be around 86 $MMTCO_2e$ per year, so we would likely use up the rest of our budget by 2030. Deferring action and staying on the business-as-usual path means we would have used our entire emissions budget up, and still have twenty more years to go in the budget period. This illustrates why we simply cannot afford to wait.

Meeting Oregon's goals in light of the expected population increases in Oregon will be one of the many challenges facing policy makers in the years ahead. Figure 9 illustrates the per capita emission reductions necessary to meet Oregon's greenhouse gas goals in light of expected future population growth.

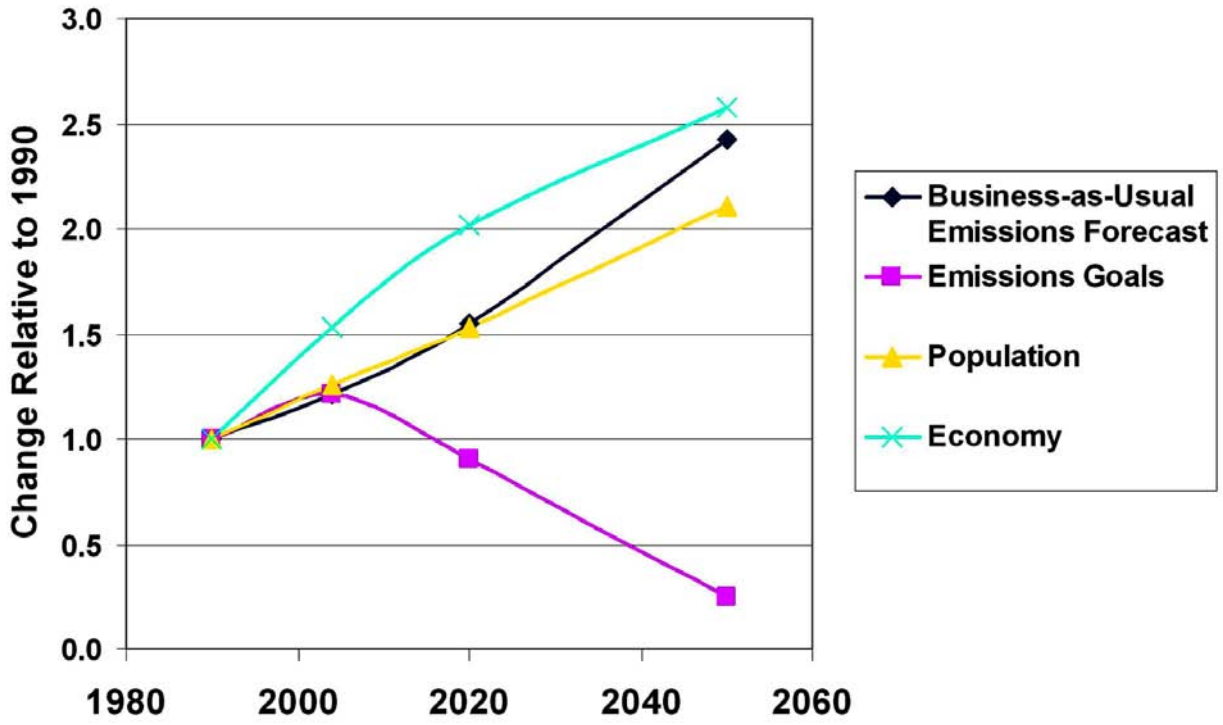
Figure 9: Forecasted Emissions and Emission Reductions Necessary to Meet Oregon's Greenhouse Gas Goals on a Per Capita Basis



It will also be necessary to "decouple" economic growth from its historic relationship to emissions growth by "retooling" the economy so that economic growth can be aligned with the goals of reducing emissions. This will be possible if the new market opportunities presented by a carbon-constrained economy can be captured here in Oregon – opportunities already seeing growth in the state

such as the renewable energy industry and the "green" economy. Figure 10 represents (on a scale relative to 1990) the current projections for Oregon's economy and population as compared with combined historical and business-as-usual emissions, and the emissions necessary to achieve Oregon's greenhouse gas reductions goals. This figure outlines the challenge ahead in "decoupling" emissions growth from economic growth.

Figure 10: Projected Growth Relative to 1990 of Oregon's Economy, Population, Business-as-Usual Emissions, and Emission Reductions to Meet Greenhouse Gas Goals



5. Recommended Actions

The Climate Change Integration Group was charged with assessing whether any additional mitigation actions – beyond those identified in the 2004 *Oregon Strategy for Greenhouse Gas Reductions* – should be identified at this time for action. In examining whether any additional mitigation actions should be highlighted, the circumstances and context behind the 2004 effort were also examined by the group. Since several of the members of the original advisory group to the Governor were also on the CCIG, they were able to bring their experience from that original effort to the workings of the CCIG.

The CCIG took a three-step approach to deciding whether to recommend additional mitigation actions beyond those in the 2004 *Oregon Strategy* report. First, it was widely acknowledged at the time of the deliberations surrounding the 2004 *Oregon Strategy* that land use measures were not given enough attention. This was intentional, for at the time the report was being constructed, there was considerable uncertainty around land use policy and planning in the state, and the "Big Look" process in particular.

Therefore, CCIG members felt that this shortcoming of the 2004 *Oregon Strategy* should be addressed in this final report of the CCIG. As a result, following this section is a chapter with several transportation and land use policy recommendations.

Secondly, an extensive list of policy recommendations from the 2004 *Oregon Strategy* process was deferred at the time for several different reasons. Out of respect for the original 2004 *Oregon Strategy* process, and in the spirit of continuity, the CCIG examined the entire list of deferred measures to see whether there were measures from those deliberations that should now be highlighted for further action. In fact the CCIG agreed with the original advisory group and did not feel that any of those policies need to be brought to light at this time. Ironically, the rapid pace of progress in this area had already seen many of those policies put into action even without either group's specific blessing. The CCIG did ask to keep that set of policies alive for future consideration, and they are included in this report in Appendix 4.

Finally the CCIG members deliberated as to whether to add any additional mitigation measures for more detailed examination in this report, other than the land use and transportation measures included here. Given the early stage of implementation for so many existing measures, members agreed it was most useful to add points of emphasis and perspectives to the existing *Oregon Strategy.* In general, CCIG members urge that the state redouble its efforts toward completing actions and measures identified in the 2004 *Oregon Strategy* that have either not seen sufficient progress, or have fallen in the "not yet implemented" category to help accelerate progress toward Oregon goals. CCIG members felt particularly strongly that the energy efficiency measures identified in the report and "in progress" at the current time need special attention given the importance of those actions.

The CCIG also recommends that the state add a "whole building" perspective to maximize opportunities in the buildings sector. Such an approach accounts for greenhouse gas emission reductions and other benefits stemming from an integrated approach toward site location, development and encouragement of alternative transportation; water use; materials choices; energy efficiency and renewable energy; and indoor environmental quality. This approach will also capitalize on Oregon's leadership in the burgeoning high performance green building market and will further amplify connections among green buildings, land use and transportation. This approach also takes advantage of the innovative Oregon Business Energy Tax Credit program targeted to certified green buildings.

The CCIG also felt that some internal state agency organization needs should be addressed. Those recommendations are included in the next section.

6. Recommended Organizational Actions

The CCIG recommends that the governor designate a lead agency for each of the sectors that generate greenhouse gas emissions in the state.

- The Oregon Department of Transportation (ODOT) as the lead agency for the transportation sector
- The Department of Land Conservation and Development (DLCD) as the lead agency for land use
- The Department of Environmental Quality (DEQ) as the lead agency for the industrial sector

- Oregon Housing and Community Services as the lead agency for the residential sector
- The Oregon Economic and Community Development Department as the lead agency for the commercial sector
- The Oregon Department of Agriculture (ODA) as the lead agency for the agricultural sector
- The Oregon Department of Energy (ODOE) as the lead agency for the energy generation sector
- The Oregon Department of Forestry (ODF) as the lead agency for the forestry sector

The CCIG recommends these agencies not because they are primarily responsible for their sectors' greenhouse gas emissions, but because they are the administrative bodies with the authority to convene and regulate the wide array of responsible parties within each sector.

As a first step, the CCIG recommends that each agency conduct a baseline inventory of the greenhouse gas emissions within its sub-sector. It is important that this inventory be conducted in a manner consistent with the inventories conducted by other agencies within Oregon, such as the Greenhouse Gas Reporting recommendations being developed by DEQ, but also with inventories used by agencies in other Western states, other organizations, and even governments abroad (such as The Climate Registry and European Union nations). This will facilitate best practices sharing between agencies and ensure a consistent approach to what is ultimately a global problem. Each lead agency should then adopt the target emissions levels required by statute for its sub-sector:

- By 2010, arrest the growth of Oregon's greenhouse gas emissions and begin to reduce them.
- By 2020, achieve greenhouse gas levels that are 10 percent below 1990 levels.
- By 2050, achieve greenhouse gas levels that are at least 75 percent below 1990 levels.

Each lead agency should then create a list of potential greenhouse gas mitigation strategies that can be followed in order to meet the future target emissions levels. The emissions reductions potential and the cost of implementing each strategy should be included. This will enable lead agencies to prioritize the strategies that are the most cost-effective.

Each lead agency shall then be responsible for tracking progress towards the target emissions levels in its sub-sector, reporting progress to the Global Warming Commission, and setting step-down targets as required. Should additional resources or funds be required to meet target emissions levels, agencies shall be responsible for communicating those needs to the Global Warming Commission and to the Legislature.

Reducing across-the-board greenhouse gas emissions will require extensive coordination between state agencies, local governments, and the private sector. Cross-collaboration between state agencies should be ensured since we need a systems-wide approach. A mechanism where state agencies come together – perhaps with their local and federal counterparts – for regular meetings should be put in place. Moreover, Oregon is not alone in addressing climate change. Many other state governments, particularly in the western U.S., and federal governments in Europe have already developed and implemented policies to reduce greenhouse gas emissions. As successful methods of mitigating the effects of climate change are developed, Oregon will benefit by being prepared to coordinate its efforts with national and international programs.

7. Transportation and Land Use Sector Recommendations

This chapter outlines actions that will reduce greenhouse gas emissions from the transportation sector. Overall, this report focuses more on the transportation sector and the link between transportation and land use than previous reports. This is because the transportation sector's share of greenhouse gas emissions is growing rapidly, and less progress has been made in this sector compared to other sectors such as electricity generation, where significant legislation such as the Renewable Portfolio Standard has been passed to help address greenhouse gas emissions.

7.1 Introduction

The transportation sector accounts for 34 percent of Oregon's greenhouse gas emissions, second only to electricity in its share of overall emissions. Transportation's greenhouse gas emissions are only projected to increase, and technological improvements alone will not solve the problem. Intelligent transportation and land-use planning and policies will be necessary to meet the state's goal of reducing greenhouse gas emissions by 75 percent below 1990 levels by 2050.

Fortunately, changing the way that we get around has benefits that reach far beyond emissions reductions. Transportation accounts for not only a large portion of greenhouse gas emissions, but also a large share of household budgets for the average Oregonian. In FY 2004-05, the average household in the western states spent $9,498 on transportation, 18.9 percent of total expenditures. Innovative transportation policies and planning can reduce this financial burden. In the same period, the average household in the Portland area, which is known for promoting travel options and limiting sprawl, spent only 17.6 percent of its total on transportation.[13]

The effects of these savings extend far beyond their dollar value. A recent study calculated that Portland-area residents, whose median commute is four miles shorter than the average American's, save a total of $2.6 billion per year due to reduced transportation costs and the value of time that would have otherwise been spent traveling.[14] Many transportation expenditures, notably the cost of gas, leave the local economy, while this extra $2.6 billion stays in circulation in the region. This figure does not take into account the personal health benefits of increasing the share of transit and non-automotive modes, which increase physical activity and air pollution, and thereby, over time, translate into lower health care costs. Integrated, multi-modal transportation and land-use planning not only reduce emissions, but save money as well.

In order to assist lead agencies in the transportation and land-use sectors in choosing methods to reduce greenhouse gas emissions, the CCIG will present information on a variety of mitigation strategies. For the transportation and land use sector, these strategies fall into four broad categories:

- Use of low-carbon fuels
- Use of cleaner and more efficient vehicles
- Reduction in vehicle miles traveled (VMT)
- System management and optimization

[13] U.S. Census Department, "Average Annual Expenditures of all Consumer Units by Size and Region, 1995 to 2004," http://www.census.gov/compendia/statab/tables/07s0668.xls. The national average is 18 percent.

[14] Cortright, Joe, "Portland's Green Dividend," pg. 1, http://www.ceosforcities.org/internal/files/PGD percent20FINAL.pdf.

7.2 Strategies to increase the use of low-carbon fuels

Low-carbon fuels are fuels that, when burned, create significantly less carbon dioxide (CO_2) than electricity. Ethanol, commonly distilled from corn in the United States or from sugarcane and grasses abroad, has received much public attention lately; but biofuels made from glycerides in cooking oil, hydrogen fuel cells, compressed natural gas, and electricity are also viable alternatives to conventional gasoline.

When considering investments in low-carbon fuels, it is necessary to examine the well-to-wheel (WTW) carbon emissions of a fuel source. Certain fuel sources, e.g., hydrogen fuel cells and electricity, create few or no greenhouse gases when they burn, but are energy-intensive to produce. Their WTW emissions depend entirely on the energy source used to produce them. Cellulosic ethanol, biodiesel, and compressed biogas are among the lowest WTW emissions fuels.[15]

It is also necessary to consider the long-term financial impact of creating a wider market for a given fuel source. Some low-carbon fuels, e.g., corn-based ethanols, are produced from by-products of other processes. The market for these fuels is favorable as long as there is a surplus of these by-products, but as the market becomes saturated or input prices are affected by changes outside of the energy market, the price of production may rise. For example, between 2005 and 2007, corn prices doubled, due in part to the new demand for corn from the growing number of ethanol distilleries in the U.S. Meanwhile, the price of ethanol fell due to overproduction, but since corn purchases constitute 70 percent of the price of ethanol, long-term prices are expected to rise in the absence of federal subsidies.[16] Furthermore, ethanol is corrosive and absorbs impurities, so it cannot be shipped through existing pipelines, and, instead, requires more energy-intensive transportation. This is not to say that ethanol itself is an inferior fuel source, but it is currently the most widely used alternative to gasoline, and the consequences of its adoption so far illustrate the wide range of financial and infrastructural impacts that must be considered.

The introduction of new fuels or fuel additives may have unintended health consequences. Research on these possible health effects should be encouraged. In addition, monitoring of the population for unexpected health outcomes as these substances are more widely used is prudent. This will require strengthening of Oregon's public health infrastructure to ensure that adverse health effects can be detected.

The State can promote low-carbon fuels either through incentives or regulation. It can provide incentives for:

- In-state production of low-carbon fuels.
- Drivers that use low-carbon fuels in their vehicles.

The State can also help make the sale of alternative fuels more commercially viable for the private sector by offering subsidies or other incentives, such as allowing alternative fuels to be sold on state-owned land or highway right-of-way. Helping to increase the supply of alternative fuels in this way will result in increased adoption of alternative fueled vehicles by the public, since refueling locations will be widespread, convenient, and accessible.

[15] EUCAR/JRC/CONCAWE, "Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context," http://ies.jrc.cec.eu.int/wtw.html.

[16] Krauss, Clifford, "Ethanol's Boom Stalling as Glut Depresses Price," The New York Times, Sept. 24th 2007, http://www.nytimes.com/2007/09/30/business/30ethanol.html.

Furthermore, the State can require that:

- Government vehicles and companies working on behalf of the state, such as contractors undertaking highway construction work, use low-carbon fuels.
- Gas stations provide consumers with low-carbon fuels. California has created a low-carbon fuel standard requiring that all refiners, blenders, producers and importers of transportation fuel reduce the carbon content of fuel by 10 percent by 2020, and creates a market-based mechanism for achieving these reductions.[17]

Combustion of new low-carbon fuels or fuels with new additives may have adverse health effects, as was discovered with the addition of MTBE to gasoline some years ago. As part of a strategy to increase use of these fuels, the state should develop, adequately fund and implement an effective monitoring system for health effects related to combustion of these fuels.

7.3 Strategies to increase the use of cleaner and more efficient vehicles

A variety of technologies that reduce emissions by making cars more fuel-efficient or by trapping and sequestering greenhouse gases before they enter the air are becoming available. In 2005-06, the average fuel economy of new vehicles increased for two consecutive years for the first time since the 1980s,[18] driven up by rising oil prices and new technology. Most popular are drive-train improvements such as fuel-efficient engines, tailpipe emissions controls, and in particular hybrid gas-electric engines.[19] Powertrain and non-engine improvements such as lightweight materials, aerodynamics, and idling reduction also improve fuel economy by lowering the amount of energy that it takes to move a vehicle or by automatically turning off engines when a vehicle is stopped.

When weighing the benefits of different technologies that increase fuel efficiency, it is important to examine not just how much these technologies reduce greenhouse gas emissions, but how cost-effectively they do so. While hybrid engines are currently a popular method of making vehicles more fuel efficient, they carry high premiums. On average, consumers pay $3,500 more for a light-duty vehicle with a hybrid engine than for a comparable vehicle with a conventional engine. Vehicles that are lighter, more aerodynamic, and have less rolling resistance can achieve increased fuel efficiency while using conventional engines, sometimes at a lower cost. Analysts from Ford Motor Company have concluded that "light weighting" could double fuel efficiency at a cost of $1000 per vehicle.[20] A 2007 study concluded that non-engine improvements in aerodynamics, reduced idling, and "lightweighting" for commercial and light-duty vehicles have the lowest cost per ton of reduced CO_2 emissions, while biodiesel, hybrid engines and plug-ins for light-duty vehicles have the highest cost per ton of reduced CO_2 emissions.[21] While the auto industry has so far focused on engine improvements to increase mileage, it will benefit the State to consider non-engine improvements as new technologies become available.

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[17] California Energy Commission, "Low-Carbon Fuel Standard." http://www.energy.ca.gov/low_carbon_fuel_standard/.

[18] Environmental Protection Agency, "Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through2007," September 2007, http://www.epa.gov/otaq/fetrends.htm.

[19] Associated Press, "Hybrid Sales Up 49 Percent," September 17th, 2007.

[20] Ogden, Joan M., Robert H. Williams, Eric D. Larson (2004) Societal Lifecycle Costs of Cars with AlternativeFuels/Engines. Energy Policy 32 (1), 7 – 27, cited in Vattenfall AB, "The Landscape of Global Abatement Opportunities up to 2030, Transport Sector," June 2007, pg. 8.

[21] Vattenfall AB, "The Landscape of Global Abatement Opportunities up to 2030, Transport Sector," June 2007, pg. 8, http://www.vattenfall.com/www/ccc/ccc/Gemeinsame_Inhalte/DOCUMENT/567263vattenfall/P0272864.pdf.

Other new technologies integrate plug-in hybrid electric vehicles (PHEVs) with the energy grid, benefiting both drivers and energy suppliers. Vehicle-to-grid (V2G) is a system currently under development that connects PHEVs to the power grid. During peak demand periods, vehicles that are not in use sell electricity from their batteries back to the grid, while during off-peak periods cars draw power from the grid to recharge. V2G offers a double-pronged approach to reducing greenhouse gas emissions. In the transportation sector, it would encourage the use of fuel-efficient electric vehicles, and in the energy generation sector, it would create a potentially large reserve power supply that could be drawn upon during periods of peak demand, reducing the need to construct new power plants.[22] V2G could also provide a mechanism to store renewable energy, which is often generated during periods of off-peak demand, for times when it is most needed. While V2G is still in development, it is an existing technology that has the potential to revolutionize the vehicles we drive and the way electrical power is generated, stored, and used. The State could invest in further research, and in supporting existing technologies (e.g., inverters) that are crucial to implementing V2G, and could undertake pilot projects in partnership with the private sector to accelerate the deployment of V2G infrastructure.

In order to reduce greenhouse gas emissions by increasing the usage of more efficient vehicles, the State can:

- Use cleaner and more efficient vehicles in the State fleet, keeping in mind the cost-efficiency of non-engine improvements.
- Require that companies working on behalf of the State, such as contractors undertaking highway construction work, use cleaner and more efficient vehicles and retrofit equipment.
- Invest in creating infrastructure (e.g., charging and V2G facilities) for electric vehicles.
- Create its own fuel efficiency incentive programs and institute a "feebate" system that subsidizes drivers whose cars exceed threshold levels at the expense of drivers who choose cars that fall below threshold levels. Studies estimate that fuel economy standards (instituted at the federal level) tied to feebates have the potential to reduce greenhouse gas emissions by up to 18 percent by 2030.[23]

7.4 Strategies to reduce Vehicle Miles Traveled (VMT)

Strategies to reduce VMT differ from the strategies in the other three categories in that they require long-term planning to implement. While the results of VMT-reducing strategies will be felt only in the longer term (although public health benefits may result in the short term[24]), it is the area in which the State can have the most influence, both because VMT-reducing strategies extend outside of the transportation sector and across agency lines to land-use and housing, and because other strategies (such as low carbon fuels and more efficient vehicles) may be most effectively addressed at the federal level. In addition, reducing VMT is simply the single most effective way to reduce greenhouse gas emissions.

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[22] Penney, Terry, and Elling, Jennifer, "The Race to Connect Cars, Communities, and Renewables," Geotimes, August 2005. http://www.geotimes.org/aug05/feature_pluginhybrid.html.

[23] Greene, David L., and Schafer, Andreas, "Reducing Greenhouse Gas Emissions from U.S. Transportation," Pew Center on Global Climate Change, May 2003, pg. 54. http://www.pewclimate.org/docUploads/ustransp.pdf.

[24] Efforts to reduce VMT are also underway in the public health sector as ways to prevent obesity. Improving the integration of public health perspectives into land use planning activities, such as through the institution of healthrisk assessments, may result in synergy between these two efforts.

Total U.S. non-freight VMT is projected to increase by 1.8 percent annually over the next 10 years, while the average fuel economy of a passenger car is projected to improve by roughly 0.75 percent per year over the same period.[25] While Oregon has been partially successful in slowing its rate of VMT growth to 1.3 percent per year,[26] it has not slowed growth enough for improvements in technology to even hold transportation-sector greenhouse gas emissions constant, let alone to reduce them. In between 1994 and 2004, average passenger car fuel economy increased at only 0.268 percent per year,[27] a figure that does not account for the higher market share of light-duty trucks as SUVs and minivans, which have a much lower fuel economy. Even the most stringent feasible standards for fuel economy and low-carbon fuel content, coupled with the most optimistic projections for improvements in automotive technology, will likely be insufficient to even lower greenhouse gas emissions to 1990 levels by 2030.[28]

7.4.4 Pricing policies to reduce VMT

Many VMT-reducing strategies are pricing policies that aim to lower the demand for single-occupant vehicle (SOV) trips that constitute the bulk of American travel. Generally, pricing policies are ways of implementing a performance-based payment system for the use of roads, as well as internalizing some of the external costs of using a car. Free parking, maintenance, congestion, and the eventual costs of adapting to climate change are all subsidized with taxes, higher consumer prices, and time costs, shifting the economic burden away from users of the transportation system. Pricing policies are one attempt to move towards a "fee for service" type of policy model for the transportation sector. Examples of pricing policies include:

- Congestion pricing on major highways, varying in accordance with the time of day to reflect peak and off-peak demand.
- Increasing the price of curbside and garage parking.
- Cordon prices, which levy a fee on vehicles entering the central area of a city.
- Reducing/eliminating minimum parking requirements for businesses, or creating maximum parking requirements. Minimum parking requirements are often based on infrequent peak events, and may result in large underused parking areas for much of the rest of the time. Minimum requirements can provide a bias in favor of car drivers at the expense of pedestrian, bicycle, and transit users.
- Carbon taxes on greenhouse-gas producing energy sources, e.g., crude oil, which would in turn cause the price of gasoline at the pump to rise.
- Emissions/VMT taxes, collected based on odometer readings at the pump or via insurance payments.

The policies listed above have varying degrees of effectiveness, feasibility, and side benefits at the state level. Additionally, there are concerns about inequitable impacts on different economic sectors of the population from such policies. Nonetheless, carbon and emissions/VMT taxes can be effective since they directly tax

[25] U.S. Energy Information Administration (EIA), "Table 50: Light Duty Vehicle Miles Traveled by Technology Type," 2007 International Energy Outlook, 2007. http://www.eia.doe.gov/oiaf/aeo/supplement/pdf/suptab_50.pdf.

[26] Oregon Department of Transportation, Oregon Transportation Plan, September 2006, vol. 1, p. 18,http://www.oregon.gov/ODOT/TD/TP/docs/ortransplanupdate/2007/OTPvol1.pdf.

[27] U.S. Department of Transportation Bureau of Transportation Statistics, "Average Fuel Efficiency of U.S. Passenger Vehicles and Light-Duty Trucks," http://www.bts.gov/publications/national_transportation_statistics/html/table_04_23.html.

[28] Ewing, Reid; Bartholomew, Keith; Winkelman, Steve; Walters, Jerry; and Chen, Don, Growing Cooler: The Evidence on Urban Development and Climate Change, Urban Land Institute, 2007, p. 6,http://smartgrowthamerica.org/gcindex.html; and Greene and Schafer 2003, pg. 54.

greenhouse gas emissions, potentially reducing overall emissions by 6-9 percent,[29] but are difficult to implement without federal support. Studies estimate that congestion pricing is capable of reducing VMT by as much as 5.7 percent.[30] Meanwhile, parking pricing can reduce VMT by up to 4.2 percent,[31] and is the easiest pricing policy to implement at the municipal level.

It is important to note that pricing policies carry substantial economic benefits, both for users of the transportation system and for the governments that plan and invest in it. A 2007 study estimated that improved system investments of less than $1.5 billion per year would produce benefits of $1.7 billion per year by 2025 due to decreased travel times and vehicle maintenance costs for workers as well as improved freight movement for businesses.[32] Traditionally, improvements in transportation systems have focused on supply, increasing capacity to meet travelers' needs. However, new infrastructure is expensive and may induce demand, locking governments into a spending cycle of adding increasingly more capacity as more drivers take advantage of new facilities. Pricing policies, on the other hand, reduce demand for travel, and tolls can be used to fund system improvements. New transponder technologies make it easy to collect tolls without slowing traffic and vary charges according to peak demand. Stockholm and London are both examples of cities that have implemented cordon pricing, and while a majority of residents were initially opposed to the idea, two-thirds of residents now support pricing after seeing the impact that it had on congestion.[33] An important ingredient to the success of these programs, however, was a substantial increase in spending (from revenues generated through the program) in public transit and other mobility improvements for affected citizens.

7.4.5 Transportation options programs to reduce VMT

Other methods reduce VMT by shifting trips to more energy efficient modes. Currently, 71.4 percent of Oregonians drive alone to work,[34] which produces far more greenhouse gases per person/mile than other modes such as carpooling, bicycling, walking, transit and rail. The State can invest directly in improving transit service, creating vanpools, or in building pedestrian or bicycle facilities in areas that are underserved. The majority of all federal transportation dollars are flexible, yet 53 percent of them go toward highway infrastructure, while only 12 percent go toward transit.[35] The State could redirect more of this funding toward alternative transportation instead of using it primarily to build new roads.

However, many cities already have transit or bicycle/pedestrian systems that are underutilized, and the State can also help by investing in programs to promote transportation alternatives. Transportation alternative promotion programs include:

- Programs and websites that promote ridesharing, such as carpoolmatchNW.org, a Portland-area service that matches up commuters that have common destinations.
- Employer trip reduction programs, such as telecommuting and compressed work weeks, which reduce the number of days that employees commute to work.
- Educational programs such as outreach programs to promote non-SOV transportation modes.

[29] Greene and Schafer 2003, pg. 54.
[30] Greene and Schafer 2003, pg. 45.
[31] Ibid.
[32] Economic Development Research Group, The Cost of Highway Limitations and Traffic Delay to Oregon's Economy, 2007, pg. 49.
[33] Replogle, Michael, "Improving Mobility While Meeting the Climate Challenge," Presentation to the City of Portland, Multnomah County, and ODOT, November 19, 2007.
[34] U.S. Census Bureau, 2006 American Community Survey.
[35] U.S. Department of Transportation and Bureau of Transportation Statistics, "Table 4-A: Transportation Expenditures by Mode and Level of Government from Own Funds: FY 1985-2003," in *Government Transportation Financial Statistics* 2003, November 2004, p. 49.http://www.bts.gov/publications/government_transportation_financial_statistics/2003/pdf/entire.pdf.

- Individualized marketing campaigns such as Salem-Keizer, Eugene, and Bend's TravelSmart program or the Portland area's Drive Less, Save More program, which compile resources from different local transportation agencies and resources, provide simple advice on how to conserve fuel, and offer economic and environmental information in order to help users make responsible transportation choices.
- Creating and funding Transportation Management Associations (TMAs), which work with neighborhood businesses and residents to develop locally-targeted sustainable transportation strategies.

7.4.6 Land-use planning to reduce VMT

Innovative land-use planning that addresses urban sprawl and growing commute distances has a large potential to reduce carbon emissions. Even if pricing policies and transportation options to the car are put in place, VMT per capita is unlikely to decrease unless sprawling suburban development patterns are addressed. Large-lot, single-use residential developments located far away from destinations require residents to drive in order to access jobs, schools, and stores. Higher-density, mixed-use developments are much easier to serve with transit and reduce the distances between residences and destinations, making bicycle and pedestrian trips much more feasible. A meta-analysis of studies comparing mixed-use neighborhoods with low-density sprawl found that doubling density, mix of uses, and street connectivity reduces per capita VMT by 33 percent.[36] The State can help to reduce VMT through better land-use planning by:

- Supporting transit-oriented development (or TOD; development that is close to transit lines and has facilities allowing residents safe access to those lines) in proportion with the projected increase in transit trips created by the development.
- Facilitating best-practices sharing between land-use planners from communities around the state, nation, and other countries.
- Creating and implementing incentives or, possibly, requirements for VMT – or greenhouse gas-reductions in local governments' comprehensive plans and development proposals. For comprehensive plans, this could be achieved by requiring cities or counties to do greenhouse gas or VMT inventories, setting goals for per capita greenhouse gas emissions or VMT, and evaluating proposed comprehensive plans based on how much progress they make toward goals. On a project-by-project basis, cities could require developers or planners to include VMT or greenhouse gas estimates in proposals and awarding development credits based on reductions achieved. In order to ensure a consistent approach, the State would need to develop a methodology for VMT or greenhouse gas estimates. King County, Washington, is currently developing such a methodology for all land-use and transportation plans.
- Encouraging high performance green buildings that support the use of alternative transportation.

Land-use planning improvements are especially effective because of the long-term duration of the built environment. Progressive land-use planning is cumulative by nature, since tomorrow's communities will be integrated with those built today. Furthermore, studies have shown that land-use planning has a positive impact upon public health[37] and saves households money on transportation costs,[38] providing complementary benefits to its greenhouse gas emissions reductions potential.

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[36] Ewing et al, 2007, p. 6.

[37] Ewing, Reid, and Kreutzer, Richard, Understanding the Relationship Between Public Health and the Built Environment, May 2006. http://www.cnu.org/sites/files/leed_public_health.pdf.

[38] Center for Transit Oriented Development and Center for Neighborhood Technology, "The Affordability Index: A New Tool for Measuring the Affordability of a Housing Choice," Brookings Institution, 2007.http://www.brookings.edu/reports/2006/01communitydevelopment_the-center-for-transit-orienteddevelopment.aspx.

It is important to note that none of the measures outlined above work best in isolation. The CCIG recommends a combination of pricing policies, transportation options, and land-use planning as the most effective way to reduce VMT. While pricing policies may be cost-effective in reducing driving in the short term, they will be easier to implement and more effective where accompanied by a variety of transportation options and land-use patterns that support these options, so that people continue to have opportunities to access jobs and services. Likewise, land-use planning and travel options programs will be most successful where accompanied by pricing policies that offer incentives for non-SOV trips. For that reason, the CCIG recommends that ODOT and DLCD collaborate closely when creating strategies to reduce VMT.

7.5 Strategies to optimize the existing transportation system and manage congestion

Fuel economy generally increases as vehicle speed increases up to 40 miles per hour, and then begins to decrease. Congestion and travel delay contribute to climate change because they result in inefficient vehicle operation such as stop-start maneuvers and idling, causing higher greenhouse gas emissions. There are several possible system improvements that could contribute to more efficient vehicle use, many of which make use of Intelligent Transportation Systems (ITS). These include:

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- Bottleneck removal and other strategic capacity additions at frequently-congested sites.
- Improved incident management to address travel delay (accidents, stalled vehicles, weather, work zones and other incidents cause about 50 percent of the travel delay in Oregon[39]).
- Information technology improvements, e.g., traveler information systems such as ODOT's TripCheck website.
- Traffic signal timing optimization.
- Traffic flow improvements and route diversion.
- Truck weigh station pre-clearance and truck stop electrification to reduce truck idling.
- Speed management to keep highway speeds at levels that allow for the most efficient operation of vehicles.
- Driver training programs to reduce unnecessary braking, avoid rapid acceleration, and teach other high-efficiency driving techniques.
- Reduction of peak period travel demand (also called "peak leveling") to spread out traffic demand over a longer period – e.g., workplace programs to stagger employee commute times.
- Congestion pricing or other pricing policies to reduce peak travel demand.

[39] Oregon Department of Transportation, Oregon Transportation Plan, September 2006, vol. 1, p. 21, http://www.oregon.gov/ODOT/TD/TP/docs/ortransplanupdate/2007/OTPvol1.pdf.

The reduction in overall greenhouse gas emissions that can be achieved by system improvements are small (mostly on the order of 1-2 percent[40]) compared to the other strategies discussed in this report. However, system improvements are relatively inexpensive to implement and popular with users of the system because they reduce congestion. Pricing policies are doubly effective since they both reduce the number of cars on the road and ensure that the remaining cars operate at maximum efficiency.

[40] Greene and Schafer 2003, pg. 54.

Education and Outreach

1. Summary

The Climate Change Integration Group was charged with the development of a climate change information and outreach plan. However, due to the interim nature of the CCIG, CCIG members believe it is best suited to provide the Global Warming Commission with a general roadmap for education and outreach. The Commission, as the permanent stakeholder body, will pick up the ongoing coordination of global warming policies and activities in the state and be responsible for designing its outreach and education program.

The CCIG believes that the Global Warming Commission should appoint a subcommittee, made up of stakeholders with expertise in marketing, health education, outreach and communications. This subcommittee would be responsible for the design, implementation and coordination of an education and outreach program. The Global Warming Commission should also identify and carry out the studies necessary to support research-based education and outreach programs.

It is important to note that Global Warming Commission members will be in a strong position to accurately and clearly represent complex climate change policies, recommendations, and progress in Oregon to the public. The Commission should be particularly cognizant of ongoing opportunities to emphasize coverage of policies that are being considered for adoption at the state level so that Oregon citizens can understand, support and take pride in Oregon's leadership role in addressing global warming.

2. Context

In the 2004 *Oregon Strategy for Greenhouse Gas Reductions*, the following recommendation was made in the Integrating Actions section:

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

This plan would:

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

- *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."*

The Climate Change Integration Group, as the successor to the original Advisory Group, was charged with the development of such a plan. However, due to the interim nature of the CCIG, the consensus of the CCIG members is that it is best suited to provide the subsequently created Global Warming Advisory Commission with a general roadmap for education and outreach. The Commission, as the permanent stakeholder body, will pick up the ongoing coordination of global warming policies and activities in the state and be responsible for designing its outreach and education program.

Oregon Dept. of Energy

While the *Oregon Strategy* report recommends that an information and outreach plan "inform Oregonians" (see above bullets), the CCIG recommends that a plan be developed that would not only inform, but also actively engage Oregonians in taking actions to reduce greenhouse gas emissions and prepare for the impacts of climate change.

3. Recommended Actions in 2004 Strategy and Status Report

During the course of the two years in which the CCIG met, several steps were taken to advance its understanding about 1) the prevailing attitude of Oregonians around the state toward global warming; and 2) the barriers to engaging the public in a way that successfully catalyzes actual behavioral change. First, a subcommittee was formed in 2006 that adopted communications as one of its primary tasks (see interim 2006 report) and called on a variety of outside stakeholders ranging from educators to marketing professionals and non-profit organizations to help determine some of the key issues in communicating the science of climate change, the solutions to climate change and the barriers to taking action.

Second, members of the subcommittee agreed to focus on two priorities for the second year: raising awareness of the Governor's climate change legislative agenda and providing communications support for a planned 2007 day-long workshop on updated global warming science in the Pacific Northwest. Due to a lack of resources, the workshop did not take place. Members of the CCIG engaged instead in building support for the Climate Change Integration Act (HB 3543) within several different communities, including business, industry and a grassroots base through media and public outreach campaigns. These efforts led to the successful, strongly bi-partisan passage of the bill.

Third, Oregon Department of Energy created an enhanced website and listserv. The web portal, "Oregon:

Meeting the Challenge of Climate Change," provides easy access to local and regional information, links to state agencies involved in climate change, and other resources. ODOE staff will continue to update and develop more in-depth information under each portal link. Access to the portal is at www.oregon.gov/ENERGY/GBLWRM/Portal.shtml

Visitors to the website can sign up for ODOE's Climate Change listserv and receive meeting notices; updates on Oregon, regional and national actions; and other climate change information.

At this time the portal includes the following resources:

- 2004 *Oregon Strategy for Greenhouse Gas Reductions* report
- An archive of stakeholder group meeting materials and presentations
- Summaries and copies of relevant legislation
- Links to ongoing regulatory actions at ODOE and ODEQ
- General information on climate change
- State agency internal actions on reducing emissions
- Links to ongoing regional processes (e.g., Western Climate Initiative)
- Links to the Climate Trust and the Climate Registry
- Access to educational materials about climate change
- An interactive map of local government climate change action
- Downloads of state-sponsored reports relevant to climate change

4. Current Issues and Challenges

Over the last two years global warming has emerged as an issue of top concern for many of the world's nations, industrialized nations and developing countries alike. New international agreements will be negotiated as the scientific evidence of broad, far-reaching and potentially catastrophic impacts continues to mount, almost on a daily basis. Countries are stepping up with their own policies to aggressively cut greenhouse gas emissions. Moreover, several states are stepping up to show leadership either individually or collectively as part of a regional effort.

Oregon, in particular, has demonstrated a significant capacity for adopting a strong, innovative response to the global warming challenge. In the past year alone, the State adopted several policies that will produce a substantial portion of required greenhouse gas reductions, such as a renewable portfolio standard (RPS), a biofuels standard, tailpipe emissions standards, several measures incentivizing the use of renewable energy and energy efficiency, and upgrading the "Bottle Bill," all of which were recommendations contained within the original *Strategy.*

As promising a start as this may be, further action is needed. Global warming requires a broad systemic change in the way our society produces and uses energy, manages natural resources, produces and

transports people and goods, plans development, and addresses waste. Individuals, households as well as businesses, city governments and state and federal agencies must collectively envision and implement the solutions that will keep our climate safe, grow our economy and enhance our quality of life. This kind of shared commitment is only possible if Oregonians not only understand how climate change will impact human and natural systems, but also are engaged in such a way that creates effective partnerships to meet both the challenges and opportunities of climate change.

The purpose of a statewide global warming education program should be to: 1) inform the public of the risks and opportunities of climate change; 2) provide tools and resources to make possible the fundamental thinking and behavioral changes needed for the societal shifts that climate change demands; and 3) identify the personal and societal benefits of action to reduce greenhouse gas emissions and prepare for climate change.

A variety of educational and communication strategies will be needed to help people make the transition in thinking and behavior needed to reduce emissions and prepare for the impacts of climate change. Education and awareness building will be important for people who are in the early stages of change where the focus must be on building understanding of the benefits of new approaches to sustainable economic development and environmental protection.

The challenges to these objectives are as follows:

1. Increasing public awareness of climate change has not been coupled with understanding or information about specific regional or local impacts. Nor have public institutions begun a systematic plan to cope with these vulnerabilities. Yet inertia in the atmospheric and oceanic systems will cause these impacts to worsen regardless of the success of public and private efforts to reduce greenhouse gasses. While there has been significant effort to reduce greenhouse gas emissions with energy efficiency and renewable projects, there have been few efforts in the country or in the individual states to develop plans to prepare for these impacts.

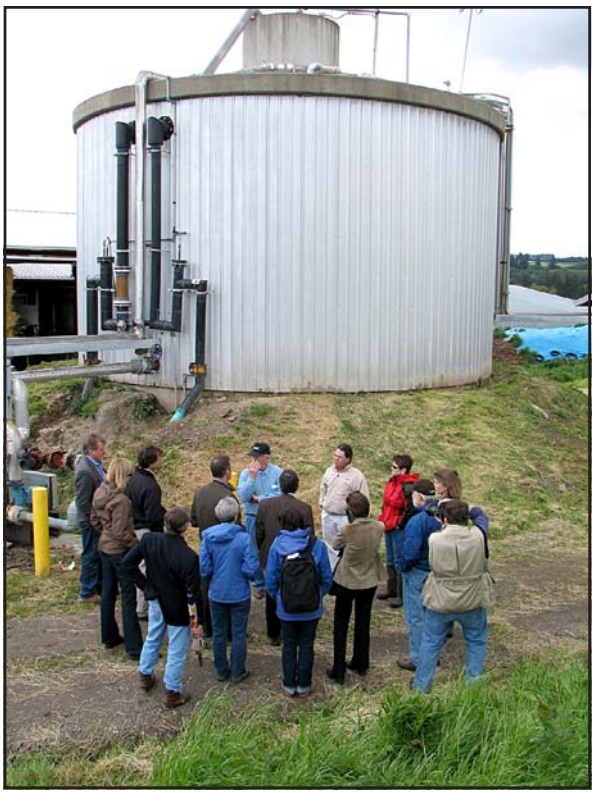
Specific threats to the human and natural environment in our primarily snow melt-dependent region and the likelihood of intense drought, wildfires, storm events, and new disease pathogens affecting human, animal and plant health have not been met with an effective public education strategy. Most government agencies and local governments do not have the capacity or the expertise to develop preparation policies and plans for natural, built, human service or economic systems, nor the information strategies to inform businesses and private citizens about these plans.

2. Notably missing from the communications activity to date related to climate change are efforts to increase awareness of the public health effects of climate change. There is a general tendency on the part of policy planners and media to focus on the more visual and readily understood environmental impacts of global warming such as melting snow pack, constricted water supplies and rising coastlines, because the public can generally understand how these impacts will affect their local communities and economies. However, complex interactions between climate change and human health may make some mosquito-borne diseases more prevalent in Oregon as temperature and rainfall patterns change. Although the linkage between shifts in climate and impacts on human health may be subtle, the impacts can be profound.

Potential health effects can be galvanizing for communities, since everyone obviously has an intimate connection with their own health. The communications challenge is the ability to make the connection between personal well-being and the complex relationship of climate change, ecosystem health and public health.

3. Although climate change poses serious challenges to businesses and local economies, it also provides significant opportunities. The need to adopt new crop varieties suitable to a changing climate may be a boon for early adopters. Growing seasons may lengthen and frost damage for fruits and vegetables may no longer be a problem. Climate refugees from high impact coastal or drought-stricken areas may enhance the work force and the economies that have the capacity to integrate them. The communication message should avoid the trap of gloom and doom, and information about impacts should be framed positively when accurate and appropriate.

4. Oregon electricity utilities are uniquely positioned to take advantage of carbon-neutral biomass generation, and carbon-free wind, solar, geothermal and hydroelectric generation as a mitigation strategy. However, the siting of new renewable generation facilities to reduce the state's overall carbon emissions will require an effective public outreach program to inform private landowners about both the benefits of these projects and their environmental and visual impacts. Furthermore, we can anticipate that there will be renewed interest in nuclear generation as a carbon-free alternative to fossil fuels. We can anticipate a need for the new Commission to inform the public about the pros and cons of this strategy, as well.



Oregon Environmental Council

5. Climate change impacts reach across social, economic and environmental boundaries and will affect all segments of the population. One of the communication challenges will be the need to tailor outreach efforts according to the needs of a diverse audience. People who are unsure of the reality of climate change will need different types of communications than those who clearly understand the risks. Farmers and ranchers have a different set of concerns from large industries and commercial businesses. As well, there will likely be competing interests for dwindling resources like water that will have to be equitably divided between electricity needs, agriculture needs and salmon restoration efforts. The challenge will be to find common ground between these separate segments and avoid the fractures that could weaken strong decision-making at the policy level.

5. Recommended Actions

1. The Global Warming Commission should appoint a subcommittee, made up of stakeholders with expertise in marketing, health education, outreach and communications. This subcommittee will be

responsible for the design, implementation and coordination of an education and outreach program that will partner with the following entities:

- Oregon Climate Change Research Institute
- State, regional and municipal agencies
- Local governments
- Special districts
- Tribes
- Non-profit organizations
- Schools
- Businesses (commercial and industrial sectors)
- Agriculture and forestry interests
- Urban and rural economic sectors
- Boards and commissions for each economic sector
- Healthcare sector
- Media outlets

The education subcommittee should identify ongoing climate change education efforts, determine the scope of those efforts and identify other priority audiences that have not been addressed.

2. The Global Warming Commission should investigate programs that are strongly rooted in the principles associated with a research-based approach to behavior change, including community based social marketing; stage-based approaches to change which use cognitive, experiential and behavioral change interventions to help people in all stages of change move from disinterest toward action; community-centered approaches that promote the empowerment of community partners and encourage collaborative design and implementation of local programs; and assets-based approaches that focus on identifying, strengthening and utilizing resources and knowledge that exist within the community itself to support behavior change. Research in the social sciences demonstrates that significant behavior change takes place at a community level when people begin to see the benefits of change as greatly outweighing the costs of action, and when barriers to change are identified and removed, and when positive actions are continually reinforced.

There are several examples of successful programs aimed at fostering climate-positive sustainable behavior within targeted communities that would serve as appropriate models for a state-wide program. One such program is the Cool Corporate Citizenship Program run by the Empowerment Institute in California. Its mission is to help companies reduce their overall carbon footprint and empower employees to follow suit at home and in their communities, achieving behavior change in not one community, but three. The Cool Corporate program focuses on providing tools to heighten employee carbon awareness, assess a carbon footprint, develop a plan for carbon reduction and, finally, ensure successful implementation.

Another very successful program is Climate Masters, developed by the Climate Leadership Initiative at the University of Oregon. Modeled after master gardener and master recycling programs, Climate Masters

consists of a 30-hour free train-the-trainer program aimed at both households and businesses in which participants learn cost-effective tools for reducing greenhouse gas emissions. Each participant than "pays" for the class with 30-hours of volunteer outreach focused on consultations that help other households or businesses reduce their greenhouse gas emissions.

Still another successful venture is the Travel Smart pilot projects that were employed in Portland, Salem-Keizer, Eugene and Bend, and focused entirely on changing mobility patterns and reducing Vehicle Miles Traveled (VMT) in these four urban areas. Instead of concentrating on diverse behavior patterns (energy use, waste disposal, travel) in one sector (e.g., neighborhoods, businesses, schools) the project's goal was to get people out of their cars and onto buses, light rail, sidewalks and bicycles regardless of whether they were traveling for school, recreation, work or errands. This approach had the benefit of reaching a wide spectrum of the population and achieving significant reductions in VMT by single drivers.

Finally, the United Kingdom (U.K.) government developed a comprehensive, evidence based, communications strategy that challenged many preconceptions about climate change and communications. A summary of this can be found in two documents, *The Rules of the Game* and *New Rules, New Game,* produced by Futerra, a U.K. communications agency.[41]

3. A communications plan should also facilitate and foster dialogue between key innovators of change. Several institutions and organizations currently exist in Oregon whose primary mission is to promote sustainability across a wide range of economic sectors, such as energy use, transportation, forestry, agriculture, green building, green jobs and municipal and county planning. There are also individuals within those same sectors whose expertise will be invaluable to those planning on a state and local level. Web-based technologies such as listserves and issue-focused networks are ideally suited to enhance communication between these groups of people. As well, efforts should be made to convene workshops and other face-to-face meetings that will improve our ability to share experience, resources and information.

4. The Global Warming Commission should identify and carry out the studies necessary to support credible research-based approaches to behavioral change programs. Initial groundwork was laid by the Institute of Natural Resources' climate change focus group project in 2006, but further research is needed to help define the target audiences and refine messaging for those audiences.

5. The Global Warming Commission should put into effect a coordinated media plan that will a) generate press coverage around global warming to help increase public awareness; b) leverage the substantial national coverage global warming is garnering by infusing stories with a unique Oregon perspective on impacts, mitigation, and preparation strategies; and c) increase understanding of the basic science of climate change.

The media plan should engage the full spectrum of media outlets currently accessed by the public. These include newspapers, radio stations and TV stations, as well as the new generation of web-based outlets such as news blogs, on-line forums and email updates. The Commission should also cultivate reporters and editorial boards for timely articles and opinion pieces as opportunities arise. The Commission should also consider developing a contact and resource list with partners in the business, academic, non-profit and

[41] The detailed strategy can be found at www.defra.gov.uk.

scientific communities who can provide additional perspectives on global warming issues. The Commission should be particularly cognizant of opportunities to emphasize coverage of policies that are being considered for adoption at the state level so that Oregon citizens can understand, support and take pride in Oregon's leadership role in addressing global warming. To that end, CCIG recommends that a global warming portal to the statewide climate change website be featured on the Governor's home page website and that of all state agencies. This strategy not only conveys the importance and cross-cutting nature of global warming, but also greatly expands information outreach.

6. Funding for the implementation of a communications and outreach plan should be allocated in the next biennium for both the Global Warming Commission (through the Oregon Department of Energy) and the Oregon Climate Change Research Institute. An initial allocation of $100,000 would provide resources for engaging a professional communications agency to assist the Commission.

Research

1. Summary

The Climate Change Integration Group has endeavored to develop suggestions for a research agenda on climate change for the Oregon University System and, to a lesser degree, for state agencies and the private sector. Research is a vital component of the framework Oregon needs to develop to assist individuals, businesses and governments to incorporate climate change into their planning processes. In addition, it is now clear that equal attention has to be given to the human dimension of climate change processes.

The CCIG recommends that the newly created Oregon Climate Change Research Institute (OCCRI) work with the new Global Warming Commission to create a Climate Change Research Working Group with representatives from water and wastewater utilities, electric utilities, general business, agriculture, forestry, transportation and non-governmental organizations focused on climate change. Such a working group could advise the OCCRI leadership on how to design and conduct a workshop of university researchers and business and community leaders to develop a research agenda for Oregon.

Two overarching needs stand out. First, baseline data needs to be developed in order to build a framework for evaluating the costs and risks of climate impacts on all sectors of Oregon's economy and communities, ranging from agriculture and forestry to urban built environments and public health. Second, understanding and forecasting climate variability and its impact on near term to multi-decadal time scales is vital. Potential changes in the variability of climate have extremely important implications for ecosystems and human activities, but are poorly understood, particularly on regional spatial scales.

2. Context

The Governor charged the Climate Change Integration Group to undertake two tasks related to research:

- **Continually assess** the sensitivity, adaptive capacity, and vulnerability of natural as well as human economic and social systems to climate change in Oregon and prepare recommendations about how the state can become more resilient and prepare for unavoidable changes; and
- **Initiate and support research aimed at identifying management opportunities and strategies** for mitigation, adaptation, and preparation in collaboration with the Oregon University System.

Given the timeline for producing this report and the limited funding available to do so, the CCIG has not been able to update the *Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest* prepared in 2004 and included as Appendix C to the *Oregon Strategy for Greenhouse Gas Reductions.*

Oregon State University

As stated in our Interim Report (see Appendix 2) we have strived to develop suggestions for a research agenda on climate change for the Oregon University System and, to a lesser degree, for state agencies and the private sector. Research is a vital component of the framework Oregon needs to develop to assist individuals, businesses and governments to incorporate climate change into their planning processes. It is now clear that equal attention has to be given to the human dimension of climate change processes; economic and policy decisions both influence and are affected by climate change. We are moving into a world with no analog in our past experience. As we move into this world, our understanding will always be changing and improving.

Oregon researchers must work closely with colleagues throughout the Pacific Northwest, as well as the national and international climate research community, in order to develop the information and analytical tools needed by Oregonians. Given limited financial resources at the state level, the CCIG believes it to be vital to leverage the state investment in the OCCRI with additional federal support for climate change research. It is also important to avoid duplication of work being done elsewhere.

3. Recommended Actions in 2004 Strategy and Status Report

3.1 2004 Research Recommendations

The recommendations of the Governor's Advisory Group on Global Warming are still relevant, especially since funding has not been available to support action on them. The greatest areas of uncertainty affecting our ability to understand and develop climate change scenarios in the Pacific Northwest still are:

> "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."

And the most important issues to be addressed in the next 5-10 years also remain the same:

- 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 effects of shifts in human management practices (urban development, etc.) on impacts to climate change?

While little progress has been made in addressing these issues, the institutional framework for studying them was created. The 2007 Legislative Assembly enacted House Bill 3543, Section 15 which created the Oregon Climate Change Research Institute (OCCRI). OCCRI will engage faculty from throughout the Oregon University System. The OCCRI is directed to:

(a) Facilitate research by Oregon University System (OUS) faculty on climate change and its effects on natural and human systems in Oregon;

(b) Serve as a clearinghouse for climate change information;

(c) Provide climate change information to the public in integrated and accessible formats;

(d) Support the Oregon Global Warming Commission in developing strategies to prepare for and to mitigate the effects of climate change on natural and human systems; and

(e) Provide technical assistance to local governments to assist them in developing climate change policies, practices and programs.

In addition, OCCRI is directed to assess, at least once each biennium, the state of climate change science, including biological, physical and social science, as it relates to Oregon, and the likely effects of climate change on the state and submit the assessment to the Legislative Assembly and to the Governor.

3.2 Oregon Climate Change Research Institute Start Up

A planning committee to organize OCCRI has been created with representatives from Oregon State University, the University of Oregon, Portland State University, Southern Oregon University and Oregon Health and Sciences University. The Planning Committee is chaired by Mark Abbott, Dean of the College of Oceanic and Atmospheric Sciences at OSU. $180,000 was appropriated for FY2009 for the OCCRI. The Planning Committee will recruit a director who will likely be able to begin work in July 2008.

The CCIG anticipates that between now and July 1, 2008, the Planning Committee will work with the new Global Warming Commission and faculty researchers to develop a research agenda aimed at

identifying opportunities and strategies for Oregon in response to climate change and its effects. A vital component of developing the research agenda will be to assess the research capabilities and faculty within the OUS system and match that assessment with an analysis of the research needs of Oregon citizens, businesses and government agencies.

We recommend that the OCCRI work with the new Global Warming Commission to create a Climate Change Research Working Group with representatives from water and wastewater utilities, electric utilities, general business, agriculture, forestry, public health, transportation and non-governmental organizations focused on climate change.

Such a working group could advise the OCCRI leadership on how to design and conduct a workshop of university researchers and business and community leaders to develop a research agenda for Oregon based upon identified user needs and a synthesis and integration of existing interdisciplinary climate change science.

To support the start up of the OCCRI and the preparation of this report, an effort was made to identify all of the climate change researchers within the OUS. A database containing biographical information and research interests has been compiled and is available at http://oregonstate.edu/~conklida/OCCRdatabase/. The database includes 99 faculty members, reflecting the depth, strength and breadth of our OUS expertise in climate science. Over 70 research fields have been identified with particular strength in ecological and human impacts.

4. Current Issues and Challenges

Despite our inability to develop a formal research agenda for Oregon, Oregonians, our university faculties and our committee have identified some critical research issues for Oregon, beyond those identified in the 2004 Report. In addition, we have become aware of research initiatives underway in other states that could guide the work of the OCCRI.

4.1 Models for State Research Initiatives

Twenty-nine states have now developed climate change action plans according to the Environmental Protection Agency. Of these, nine contain recommendations related to research, however, most of the recommendations focus solely on developing new technologies to reduce greenhouse gas emissions. While such research is certainly important, in Oregon such research should be the focus of the newly created BioEconomy Sustainable Technology Signature Research Center, not OCCRI.

The most comprehensive state climate change research program in the United States has been designed and conducted in California through the Public Interest Energy Research Program (PIER) within the California Department of Energy. We believe that the California research program could serve as a useful model for OCCRI. See http://www.climatechange.ca.gov/research/index.html.

The development process for PIER's climate change research program identified a range of interrelated research needs in five areas: 1) climate change monitoring, analysis and modeling; 2) estimating costs of reducing greenhouse gas emissions; 3) impacts of climate change on water and ecological resources;

4) sequestration of carbon in the state's terrestrial ecosystems and geological formations; and 5) the economics of climate change mitigation and adaptation in the state. The research plan is intended to produce a strategic California climate change program that can be enhanced with collaboration and funding from other state, federal, and private entities. The plan recognizes that climate change monitoring, analysis, and modeling research provides critical inputs to all other research areas, while research on the economics of mitigation and adaptation integrate the results of the other areas and helps depict their potential policy implications.

The California research agenda is intended to inform decision makers of the potential impacts of climate change in the following ways:

1. **Climate monitoring, analysis, and modeling** provide researchers with a historical context of present and past conditions in California, helps determine which models are most appropriate for providing inputs and assessing regional climate changes, and informs the development of climate scenarios that will illustrate the likelihood and severity of changes to weather and climate in California, including precipitation, average temperature, extreme heat days, and sea levels. Research objectives focus on compilation and analysis of historical climate and measurement of key variables, intercomparison of regional climate models and development of climate scenarios for the state.
2. **Inventory methods** and resolving existing uncertainties to enable the state to more accurately track greenhouse gas emissions trends.
3. **Options to reduce greenhouse gas emissions** weigh the relative costs and benefits of the available options to reduce greenhouse gas emissions to achieve the maximum benefit from public and private investment.
4. **Impact and adaptation** studies identify potential impacts and effective adaptation and preparation methods for the state, particularly with regards to ecological resources, water resources, and human health. Research is underway to identify potential impacts and effective adaptation and preparation methods for California, particularly with regards to forest and agricultural resources, ecological resources, water resources, and human health.
5. **Economic analyses** allow California to estimate both the costs of climate change and cost implications of various policy responses.

While Oregon may not be able to afford as comprehensive a research program as California, by building on the California research roadmap, it may be possible to integrate our efforts and gain added value.

Another potential model to review is the research program developed and funded by the government of New South Wales (NSW) in Australia.[42] The NSW Greenhouse Plan's Climate Change Impacts and Adaptation Research Program has allocated approximately $2 million (AU) over four years to research the likely impacts of climate change on health, threatened species, aquatic ecosystems, fires, conservation planning, invasive species, coastal impacts, terrain mapping and water.

[42] See http://www.greenhouse.nsw.gov.au/actions/agencies/decc/adaptation_research_projects

Community-based participatory research (CBPR) is a methodology that can not only produce knowledge, but also be a useful tool for public education and outreach. This methodology for research engages community partners in formulating and refining research questions, collecting data, and interpreting and disseminating the results. The research process itself thus becomes a way to engage and educate community members. The OUS has several prominent CBPR researchers, and the OCCRI should build on that strength.

4.2 Identified Oregon Research Needs

The CCIG was not able to hold formal workshops to develop a research agenda. The new OCCRI will take up this challenge. Nonetheless, the CCIG has been able to develop a better sense of research needs in several ways. First, focus groups with businesses and government were conducted by the Climate Leadership Initiative at the University of Oregon. Second, testimony to the Oregon Legislature in support of the OCCRI was prepared and submitted by the Regional Water Supply Consortium. Third, research needs were identified in several presentations to the CCIG. Finally, a workshop on Climate Change Research was held at OSU on June 14-15, 2007. The structure of the workshop was guided in part by more than 80 white papers submitted by OSU faculty and researchers from the USEPA, USGS and the USDA Forest Service Pacific Northwest Research Station in Corvallis. These white papers show the scope of climate change research being conducted at OSU and local federal agencies.

Needs and opportunities identified through these three processes provide a useful starting point for the OCCRI as it develops the research agenda envisioned by the Legislature. Two overarching needs stand out. First, baseline data needs to be developed in order to build a framework for evaluating the costs and risks of climate impacts on all sectors of Oregon's economy and communities, ranging from agriculture and forestry to urban built environments and public health. This could allow us to determine the most vulnerable sectors under a range of thresholds and to rank sectors in terms of risk.

Second, understanding and forecasting climate variability and its impact on near term to multi-decadal time scales is vital. Potential changes in the variability of climate (for example, storminess, variation in maximum temperatures, variations in rainfall) have extremely important implications for ecosystems and human activities, but are poorly understood, particularly on regional spatial scales. One of the challenges of predicting future climate change is using climate modeling tools on local to regional spatial scales, particularly in complex terrain like mountainous regions, or areas where land use is changing the nature of the land surface.

More specific research needs were identified for various industries and for Oregon communities in order to address adaptation and preparation needs, as well as economic opportunities.

4.2.7 Agriculture and Forestry

What are the temperature and drought thresholds for individual crops? What are the implications for invasive species? What are the CO_2 emissions from forest fires? What are the implications for tree species selection? One of the most profound changes to the earth in the last 200 years is the dramatic increase in atmospheric carbon dioxide, which has direct and indirect impacts on plant growth, affecting carbon cycling, higher trophic levels, food resources, and feeds back to atmospheric carbon dioxide levels themselves. These impacts are not adequately characterized or understood, but are critical for understanding future change and their implications for forestry, agriculture and fisheries.

4.2.8 Energy

What is the potential for biomass energy and what are the risks? What are the impacts of climate change on developing alternative energy? Wind power, wave power, and biofuels, as well has more traditional hydropower, are all directly affected by climate change. As these energy sources become more prevalent in the Pacific Northwest, it will be necessary to understand how a changing climate may impact their viability.

4.2.9 Water Resources

Development of more effective watershed hydrology models is needed that allows an understanding of what future rises in temperature and changes in precipitation patterns will do to basin hydrology, such as rain/snow transition zones and floodplains. Support for collaborative research on climate change on watersheds, hydrology, geology, demands, and modeling of natural and manmade water supply systems are needed that allow municipalities to better understand the potential nature of future impacts. What are the impacts of climate change on flood rule curves in storage projects, and water quality, particularly during lower flow events, and the relationship to Total Maximum Daily Loads, National Pollutant Discharge Elimination System permits and on non-point pollution loadings, fish and other aquatic species impacts, and frequency of rain on snow events?

4.2.10 Natural Resources/Wildlife

Which species are most vulnerable to climate change? How will sea level rise affect fisheries and estuaries? Research is needed on forecasting change in species distribution and abundance and in biological communities in various scenarios of climate change (and climate change interacting with land use change); understanding impacts on human society; and suggesting opportunities for mitigation of negative impacts and amplification of positive impacts on ecosystem services. Answering these questions requires research in four areas: (1) How have species and biological communities responded to climate change in the past (retrospection)? (2) How will species and biological communities respond to climate change in the future (forecasting)? (3) What does this mean for society (valuation, ecosystem services)? (4) What can we do (response)?

4.2.11 Built Environment/Communities

Given our built environment, what structures are most at risk from climate change in terms of storm intensity, flooding and sea level rise? What are the impacts of sea level rise and wave climate on coastlines, coastal ecosystems, and coastal communities? Higher sea levels and changes in the storm regime can have large impacts on regional coastal communities.

4.2.12 Crosscutting Issues

Impacts of climate change frequency and magnitude of extreme events also need to be better understood in terms of their impact on Oregon communities. Extreme events like large storms, mudslides, fire, and hypoxia are the most visible impacts of the climate system on human and biological systems. There is some evidence that future climate change will change the frequency of extreme events, with obvious potential impacts on human systems. Research on the public health-related dynamics of climate change, particularly at the local and regional levels, is also needed.

How can we create resilient communities in the face of climate change? How do people learn about/perceive climate change? How are concerns about climate change balanced/traded off with other concerns? How can we (or decide to) create resilient infrastructure? How is information/learning translated in behavioral change? Will Oregon's population increase due to refugees from more severely affected areas? What will be the affect on pathogens and allergens?

How does land use cover change and impact ecosystem function, ecosystem services, and human welfare, including impacts of land use on carbon sequestration, carbon cycling, and climate? Land use change can impact the climate system, but also feeds back on political and social systems. Impacts on carbon cycling are particularly important as more effort is made to understand the dynamics of atmospheric carbon dioxide, and the role of carbon cycling in terrestrial ecosystems in controlling atmospheric carbon dioxide and in acting as a potential sink for fossil fuel carbon dioxide.

5. Recommended Actions

The CCIG recommends that the newly created Oregon Climate Change Research Institute (OCCRI) work with the Global Warming Commission to create a Climate Change Research Working Group with representatives from water and wastewater utilities, electric utilities, general business, agriculture, forestry, transportation and non-governmental organizations focused on climate change. Such a working group could advise the OCCRI leadership on how to design and conduct a workshop of university researchers and business and community leaders to develop a research agenda for Oregon. Approximately $30,000 is needed to fund preparation and delivery of such a workshop. The purpose of the research should be to position Oregon to respond effectively to the challenges posed by climate change and to embrace the opportunities it offers to develop a new way to live sustainably on Earth.

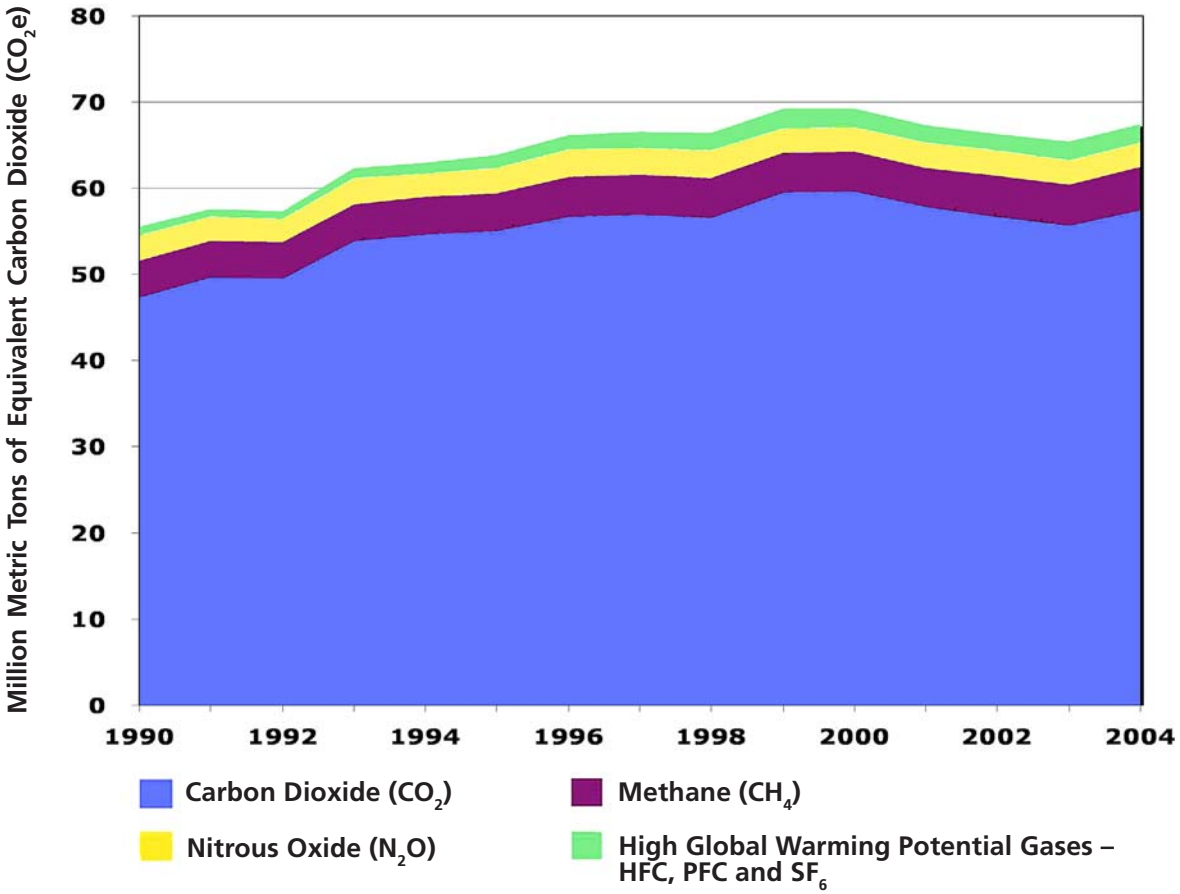
OCCRI was funded for $180,000 in General Fund appropriation and five positions (1.88 full-time equivalent positions) to operate in the second year of the 2007-09 biennium. Funding will roll-up to $360,000 in the 2009-11 biennium. The CCIG does not believe that this level of funding and staffing is adequate to meet Oregon's climate change research needs. The CCIG urges the Governor and the Legislature to increase funding for the OCCRI to the amount originally requested by the Board of Higher Education (a total of $800,000 per biennium and 3.5 FTE).

Appendix 1: Inventory and Forecast of Oregon's Greenhouse Gas Emissions

In 2004, Oregon's greenhouse gas (GHG) emissions were 67.5 million metric tons of carbon dioxide equivalent[43] ($MMTCO_2e$).[44] That was about one percent of greenhouse gas emissions for the United States as a whole, which were roughly 7.1 billion metric tons CO_2e.

Greenhouse gas emissions increased by 12 million metric tons from 1990 levels by 2004, which is a 22 percent increase over Oregon's 1990 greenhouse gas emissions of 55.5 million metric tons of CO_2e. This compares with a 16 percent increase for the United States. Figure 11 shows the change in emissions for different greenhouse gases between 1990 and 2004.

Figure 11: Oregon Greenhouse Gas Emissions 1990-2004



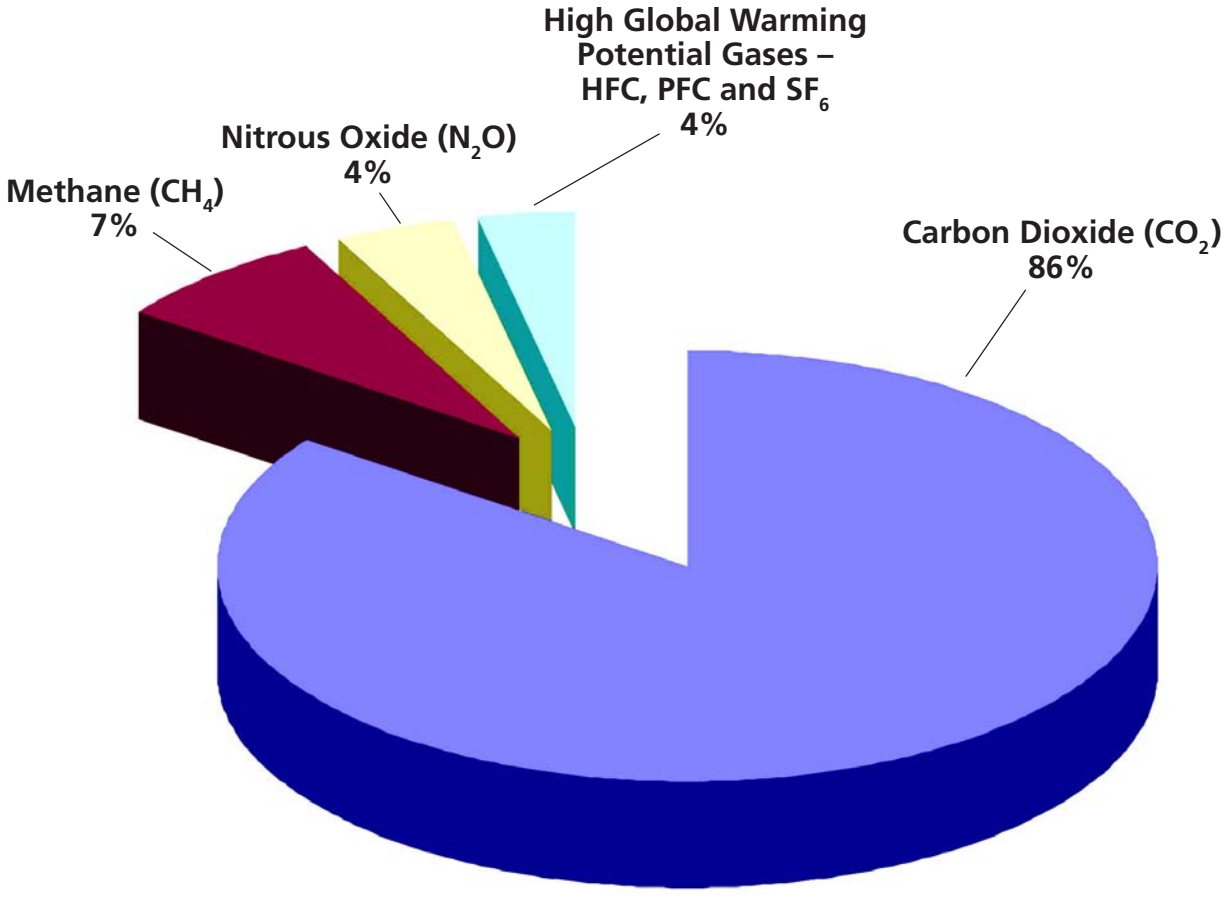
[43] "Carbon dioxide equivalent (CO_2e)" refers to a comparison of the radiative force of different greenhouse gases related to CO_2, based on their global warming potential. It is a way to compare all greenhouse gaseson a uniform scale of how much CO_2 would be needed to have the same warming potential as other gases over the same time scale. Following U.S. 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 (newer IPCC GWPs are not used in this report).

[44] The Department used the U.S. Environmental Protection Agency State Inventory Tool (SIT) for estimating greenhouse gas emissions to prepare its inventory except for CO_2 emissions from electricity use and emissions from waste. Default data in the tool are often used, but other data sources are also used.

As shown in Figure 12, the vast majority of Oregon's greenhouse gas emissions (86 percent) came from carbon dioxide (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 the manufacture of cement and from combustion of fossil-fuel derived products in burning municipal and industrial wastes.

In 2004, emissions from methane (CH_4), primarily from cattle and landfills, contributed 7 percent of greenhouse gas emissions in Oregon. Nitrous oxide (N_2O) emissions, primarily from agricultural practices, contributed about 4 percent to greenhouse gas emissions. The "high global warming potential gases" (high GWP gases) which consist of two classes of gases – hydrofluorocarbons (HFC) and perfluorocarbons (PFC) – and one individual gas – sulfur hexafluoride (SF_6) – accounted for the remaining 4 percent of emissions.

Figure 12: Greenhouse Gas Emissions Breakdown by Gas for 2004



Greenhouse gas emission data for all gases from 1990 through 2004 is provided in Table 5 along with forecast data and in Table 6 (with detailed sector data) at the back of this appendix.

1.1 Carbon Dioxide Emissions

Fossil fuel combustion is the primary source of CO_2 emissions. Emissions from fossil fuel combustion are divided into two primary categories: direct emissions from fossil fuel combustion and indirect emissions associated with the consumption of electricity in Oregon.

Electricity Generation. Electricity was the fastest growing source of CO_2 from the use of fossil fuels in the period 1990 through 2004. Emissions from electricity consumption grew 29 percent from 1990 to 2004. One reason for this increase is the phasing out of the Trojan nuclear power plant in the early 1990s.

An emerging consensus is for greenhouse gas inventories, especially at the state or regional level, to attribute energy emissions to the jurisdiction in which the energy is consumed. Following this convention, the Oregon Department of Energy calculates emissions from electricity generation based on the carbon content of the regional mix of electricity that serves Oregon's electrical load. This approach is known as a "consumption-based" inventory methodology.

Figure 13: Electricity Supply Mix in 2004

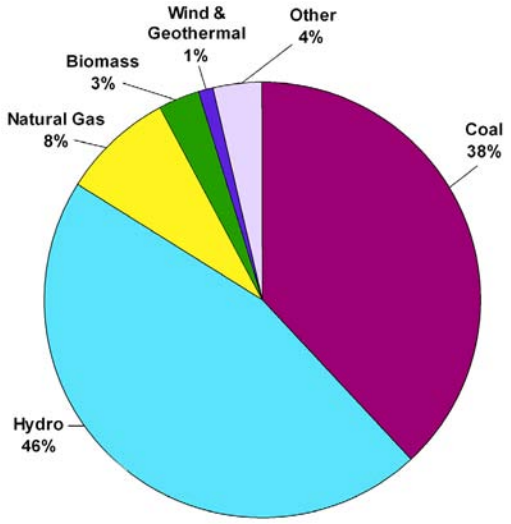
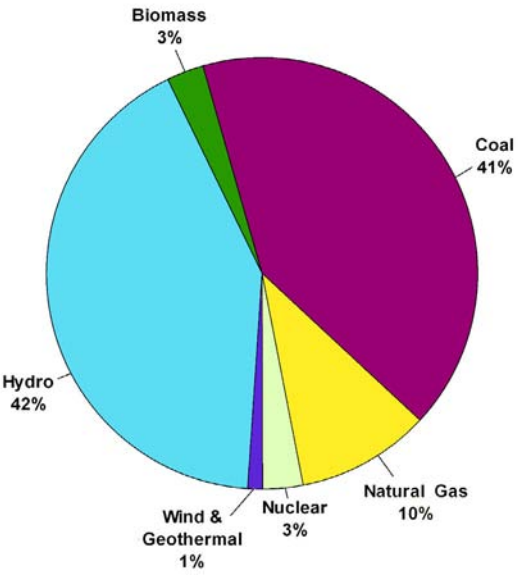


Figure 14: Electricity Supply Mix in 2005



In contrast, the federal government uses a "production-based" inventory methodology which counts emissions from power that is generated within a jurisdiction's geographic boundaries (but not from the consumption of electricity). At the national level this approach makes sense. However, the "consumption based" regional approach better reflects carbon emissions in Oregon for the following reasons:

1) Oregon's second-largest utility, PacifiCorp, has most of its power generation out-of-state, and most of that is coal-fired.
2) Taking credit for hydropower generated for the Bonneville Power Administration from Columbia River dams, as it is allocated to Oregon in national inventories, does not reflect the way that electricity (and its associated emissions) is actually distributed in the region.
3) Using a "production based" inventory as a means to measure policy actions at the state level can lead to misleading results. In effect, an action to reduce emissions only leads to an emissions reduction if the emissions are physically generated within state boundaries.

It is important to understand the interaction between the mix of power sources serving Oregon's electrical load in any given year and CO_2 emissions associated with that power. Figures 13 and 14 above show the power supply mix serving Oregon load in 2004 and 2005, respectively. Note that in 2004 a greater proportion

of Oregon's power came from zero emission hydropower sources, whereas in 2005 the ratio between coal power and hydropower was roughly equal.

Historically, Oregon has had a fairly even balance between coal and hydropower emissions serving Oregon load in any given year (roughly 40+ percent each). In those years where that balance tilts toward hydropower, there will normally be a drop in overall state greenhouse gas emissions. However, it is important to keep these year-to-year fluctuations in mind before drawing conclusions about short-term greenhouse gas emission trends for Oregon.

Emissions data for electricity were derived from several analyses. Data for 1990, 1991, and 1992 take into account the contributions of the Trojan nuclear plant based on a detailed analysis of power contracts in 1990. Data for 1993 through 2000 are based on a region-wide average of carbon content for that period. Data for 2001 through 2004 derive from detailed yearly analyses of the region-wide carbon content of electricity serving Oregon load.

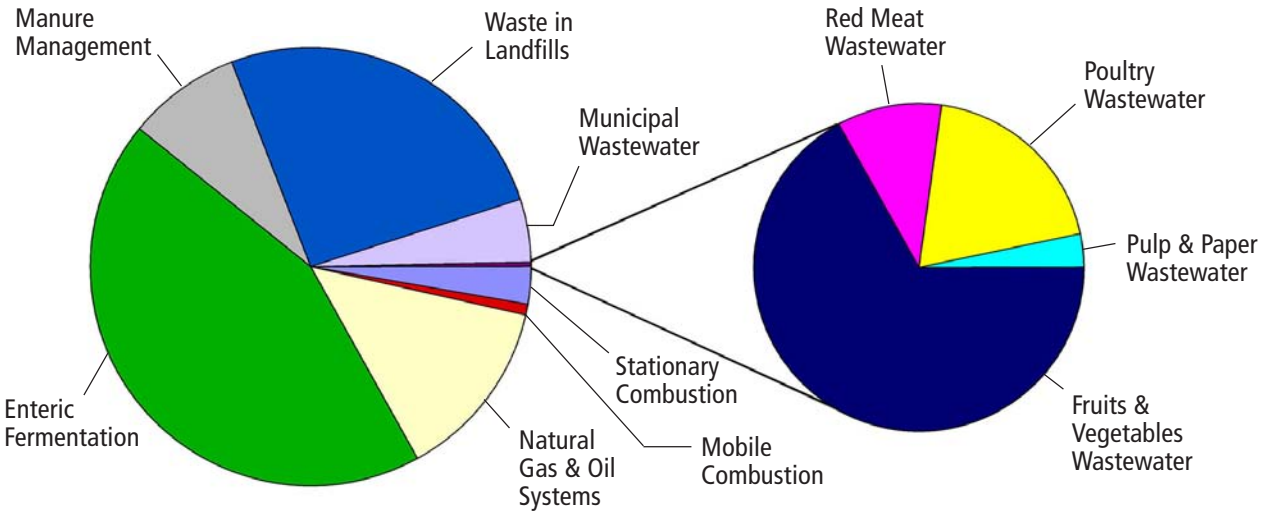
Transportation. Gasoline and diesel fuel use in transportation[45] were the largest sources of CO_2 emissions from fossil fuels at 40 percent in 2004. Emissions from transportation grew 14 percent from 1990 to 2004, but the relative contribution has changed only slightly.

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 45 and 27 percent, respectively, from 1990 to 2004. 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 essentially flat, dropping only slightly (by about 5 percent).

1.2 Methane

Methane emissions contributed about 5 million metric tons of CO_2e in 2004. That represented about 7 percent of Oregon's 2004 greenhouse gas inventory. The distribution of methane emissions for 2004 is shown in Figure 15 below.

Figure 15: Methane Emissions by Source in 2004



[45] 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.

More than half of methane emissions came from agricultural practices. Enteric fermentation, or burps from cattle and other domesticated animals, contributed 44 percent. The methane is generated in the rumen, or first stomach, of cattle and other ruminants. Another 8 percent came 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. Leaks from natural gas and oil systems (calculated from miles of pipeline and number of services) amount to about 13 percent of methane emissions. Another 5 percent came from wastewater from municipal facilities, pulp and paper production, fruit and vegetable processing, and red meat and poultry processing. Other sources include emissions from vehicles, and emissions from combustion of natural gas, distillate, residual fuel, and wood in homes and businesses.

1.3 Waste Emissions Data

Estimates of emissions from solid waste facilities combine data from several sources.[46] Oregon Department of Environmental Quality (DEQ) tracks the quantity of solid waste disposed of at landfills and incinerators in Oregon, by state of origin. (Significant quantities of garbage from Washington are disposed of in Oregon.) Estimates are also made of the quantity of mixed wastes burned by households (backyard burning, etc.). For land filling and combustion of unsorted wastes, preliminary data from Oregon's periodic waste composition studies is used to estimate the composition of wastes landfilled and incinerated. Composition estimates are combined with bulk tonnage estimates to estimate the tonnage of different materials (resins of plastics, wood, grades of paper, etc.) disposed of in different classes of facilities. DEQ's annual material recovery survey also tracks the quantities of certain wastes that are burned for energy. U.S. EPA emissions factors (carbon dioxide and nitrous oxide) for combustion of individual materials (plastics, wood, paper, etc.) are then applied against estimates of tons of each waste type incinerated.

EPA emission factors (carbon) are also applied to estimated quantities of wastes landfilled, in order to estimate sequestration of biogenic carbon buried in landfills. These sequestration estimates are assigned to the year in which the waste is landfilled. For more information on carbon sequestration estimates, see the "Net Emissions and the Oregon Inventory" section.

Estimates of methane emissions from landfills are slightly more complex. First, estimates are made of the quantity of methane generated in each landfill. Generation (and related emissions) is assigned to the year the methane is assumed to be generated, not the year in which the waste is first disposed of. For each landfill, DEQ combines time series data on waste flows, EPA-approved generation factors, and generation curves (as a function of time) developed to estimate the quantity of methane generated in any given year. To simplify the analysis, the state's very small landfills are treated as a single unit.

For wastes disposed of prior to 2003, an EPA model is used that treats waste disposed of as a homogenous mass. For waste disposed of in 2003 and subsequent years, DEQ uses waste composition data to estimate the tons of each waste type and applies these estimates against methane generation factors for individual

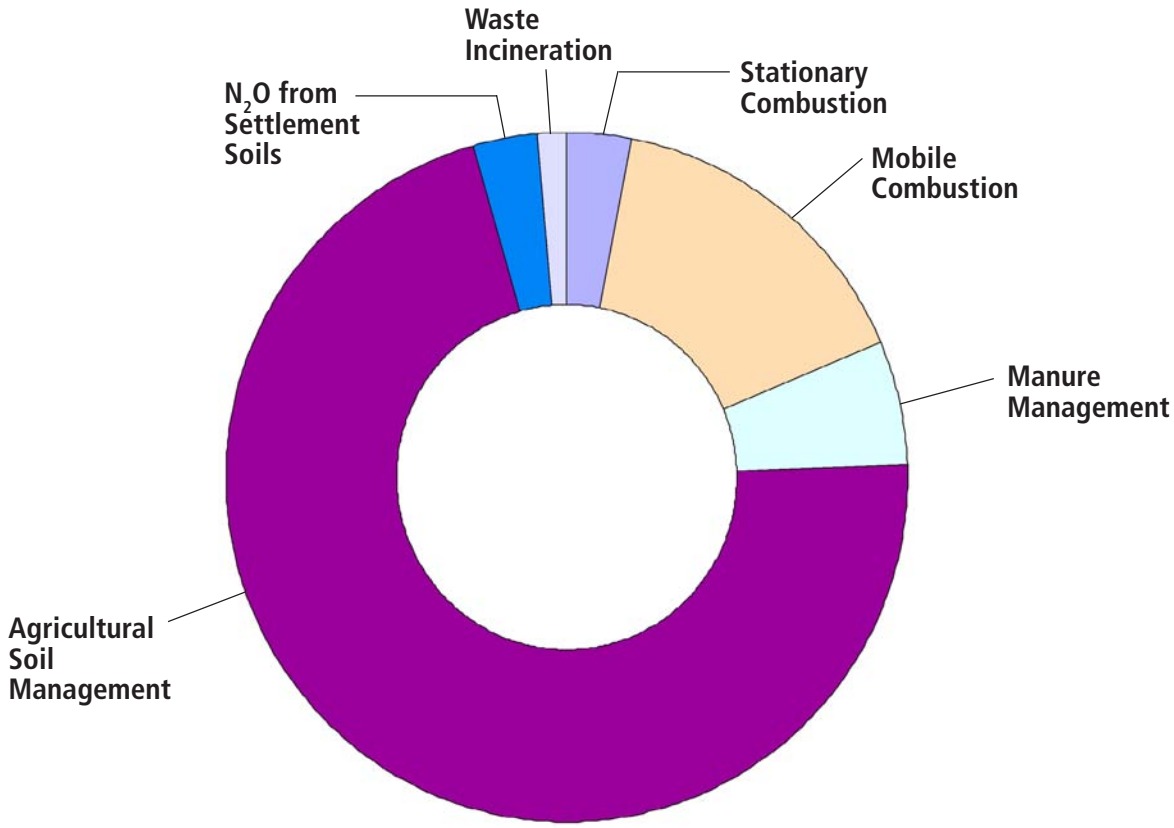
[46] It is important to note that for most materials, the emissions associated with producing materials are significantly greater than the emissions associated with disposing of them. Some of these production-related emissions are already captured in Oregon's inventory, but most are not, because they occur out-of-state. The greenhouse gas benefits of recycling and waste prevention are largely due to energy savings and forestry-related storage, not avoided emissions at waste disposal facilities.

waste types. Once methane generation is modeled, estimates are made as to the percentage of methane at each landfill that is captured through gas collection systems and the percentage of fugitive emissions that are oxidized as the methane passes through the landfill surface layer. Emissions to the atmosphere are estimated as methane generated, less methane captured and oxidized.

1.4 Nitrous Oxide

Nitrous oxide (N_2O) emissions contributed about 2.8 $MMTCO_2e$ in 2004. That represented about 4 percent of Oregon's 2004 greenhouse gas emissions. The distribution of N_2O emissions for 2004 is shown in figure 16.

Figure 16: Nitrous Oxide Emissions in 2004



(Emissions from Nitric Acid Production, Burning of Agricultural Crop Waste and Municipal Wastewater are too small to appear in Figure 16.)

The primary source of N_2O emissions (over 70 percent) 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.

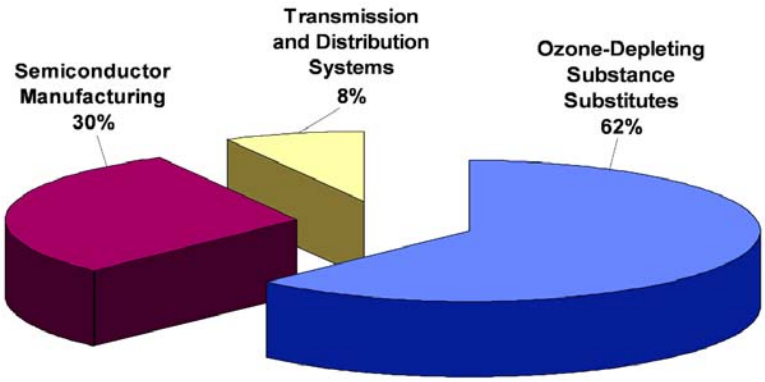
About 16 percent of N_2O emissions result from internal combustion engines and during the catalytic after-treatment of exhaust gases, but these processes are not well understood.

1.5 High Global Warming Potential Gases

The so-called "high global warming potential gases" consist of two categories of gases – perfluorocarbons (PFCs) and hydrofluorcarbons (HFCs) – and one individual gas, sulfur hexafluoride (SF_6). These gases have a global warming potential (i.e., amount of radiative forcing) that is between 140 to 23,900 times more potent than CO_2 in terms of their impact on global climate over a 100-year time span. Thus, introducing even minute portions of these gases into the atmosphere can have major impacts.

In Oregon, the key sources for high global warming potential gases are replacement coolants and various processes in the semiconductor industry. Figure 17 shows the relative share of industries that contribute to the release of these gases. Emissions of the high global warming potential gases have more than doubled between 1990 and 2004, although this is largely due to the rise of substitutes for ozone-depleting substances in the cooling industry.

Figure 17: High Global Warming Potential Gas Emissions in 2004 (HFCs, PFCs, and SF_6)



Perfluorocarbons (PFCs): Aluminum production was the major source of perfluorocarbons from 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 2004 represented all PFC emissions in this inventory.

Hydrofluorcarbons (HFCs): HFCs are most commonly used as a replacement for chlorofluorocarbons (CFCs) in cooling and refrigeration systems. CFCs were formerly the most common refrigerant, but CFCs destroys the stratospheric ozone layer. Therefore, their production is banned by international treaty. Use and discharge of HFCs is controlled as a refrigerant, but not for other uses.

Hydrofluorcarbons are used for foam blowing, fire extinguisher applications, aerosols, sterilization, and as solvents. Hydrofluorcarbons are also used in plasma etching and chemical deposition processes in the semiconductor industry. While hydrofluorcarbons do not damage the ozone layer, they are powerful greenhouse gases.

Sulfur Hexafluoride (SF_6): Sulfur hexafluoride is one of the most powerful greenhouse gases. It is 23,900 times more powerful than CO_2. The largest use of sulfur hexafluoride is as an electrical insulator in transmission and distribution equipment. Sulfur hexafluoride is also used for plasma etching and chemical vapor deposition processes in the semiconductor industry. There was some sulfur hexafluoride emitted from aluminum production as well.

1.6 Contributions from Sectors of the Economy

Different sectors of Oregon's economy contribute differently to the emission of greenhouse gases. Those contributions have changed over time. Figures 18 and 19 illustrate how key sectors contribute in 1990 and in 2004 based on Oregon's economy.

Of particular note is the continuing dominance of the transportation sector as the major source of Oregon's greenhouse gas emissions. The industrial sector is a distant second. Oregon's population growth is reflected in the increase in emissions from the residential sector, and the nation's continuing trend toward service economy jobs is likely one reason for the growth in the commercial sector. Note that the electricity consumption associated with each sector is included in both Figures 18 and 19, but is embedded as part of the sub-totals in each relevant sector.

Note that the accounting technique used for an inventory substantially shapes the perception of one sector's importance over another. Current inventory protocols tend to undervalue the contributions of the waste sector, but in the future that may change (see section 1.9 at end of this appendix).

Figure 18: Sector Contributions in 1990

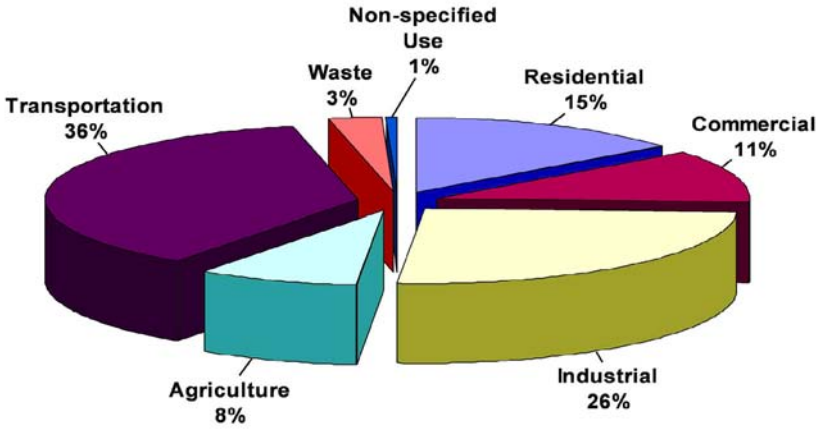


Figure 19: Sector Contributions in 2004

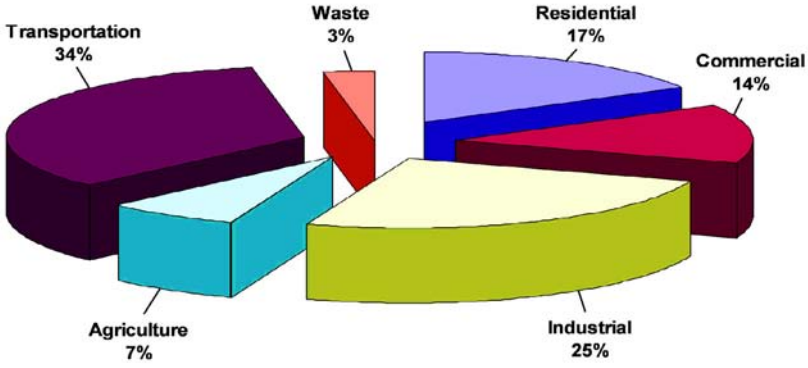


Table 5: Historical and Forecast Greenhouse Gas Emissions through 2020 (Consumption Basis)

Gross $MMTCO_2e$	Inventory Data				Forecast Data			
	1990	1995	2000	2004	2005	2010	2015	2020
Carbon Dioxide (CO_2)								
CO_2 from Fossil Fuel Combustion[1]	29.25	32.16	34.48	34.47	33.84 **	35.90	37.96	42.10
CO_2 from Electricity Consumption	16.70	21.27	23.41	21.54	23.85 *	27.01	28.92	31.49
Industrial Processes	1.11	1.19	1.46	1.06	0.98 *	1.21	1.21	1.20
Waste Combustion	0.27	0.31	0.27	0.32	0.36 *	0.31	0.32	0.34
CO_2 Total	47.33	54.93	59.61	57.39	59.03	64.43	68.41	75.13
Methane (CH_4)								
Stationary Combustion	0.10	0.10	0.10	0.14	0.10 **	0.09	0.09	0.09
Mobile Combustion	0.06	0.05	0.04	0.03	0.02 *	0.02	0.02	0.02
Natural Gas and Oil Systems	0.58	0.61	0.64	0.67	0.68 *	0.71	0.74	0.78
Enteric Fermentation	2.00	2.21	2.13	2.20	2.15 *	1.74	1.74	1.73
Manure Management	0.26	0.28	0.31	0.41	0.41 *	0.40	0.40	0.39
Burning of Agricultural Crop Waste	0.00	0.00	0.00	0.00	0.00 *	0.01	0.01	0.01
Waste	1.04	0.93	1.12	1.29	1.26 *	1.65	1.92	2.08
Wastewater	0.20	0.22	0.24	0.25	0.25 *	0.28	0.29	0.31
CH_4 Total	4.23	4.41	4.58	5.01	4.88	4.90	5.22	5.42
Nitrous Oxide (N_2O)								
Stationary Combustion	0.11	0.10	0.10	0.09	0.09 **	0.08	0.07	0.08
Mobile Combustion	0.52	0.62	0.60	0.44	0.44 **	0.32	0.31	0.27
Industrial Processes	0.00	0.00	0.00	0.00	0.00 *	0.00	0.00	0.00
Manure Management	0.11	0.09	0.12	0.16	0.13 *	0.18	0.20	0.23
Agricultural Soil Management	2.06	2.08	1.96	1.99	2.37 *	2.07	2.07	2.08
Burning of Agricultural Crop Waste	0.00	0.00	0.00	0.00	0.00 *	0.01	0.01	0.01
Waste Combustion	0.02	0.02	0.03	0.03	0.03 *	0.03	0.03	0.03
Wastewater	0.00	0.00	0.00	0.00	0.00 *	0.00	0.00	0.00
N_2O Total	2.82	2.92	2.82	2.70	3.07	2.68	2.69	2.70
HFC, PFC, and SF_6								
Industrial Processes	1.04	1.47	2.19	2.26	2.44 *	1.62	2.00	2.41
Total Emissions	**55.42**	**63.72**	**69.19**	**67.36**	**69.42**	**73.63**	**78.32**	**85.66**

* = Inventory data for 2005 ** = Forecast data for 2005 from EPA projection tool (data for 2005 inventory due in 2008)

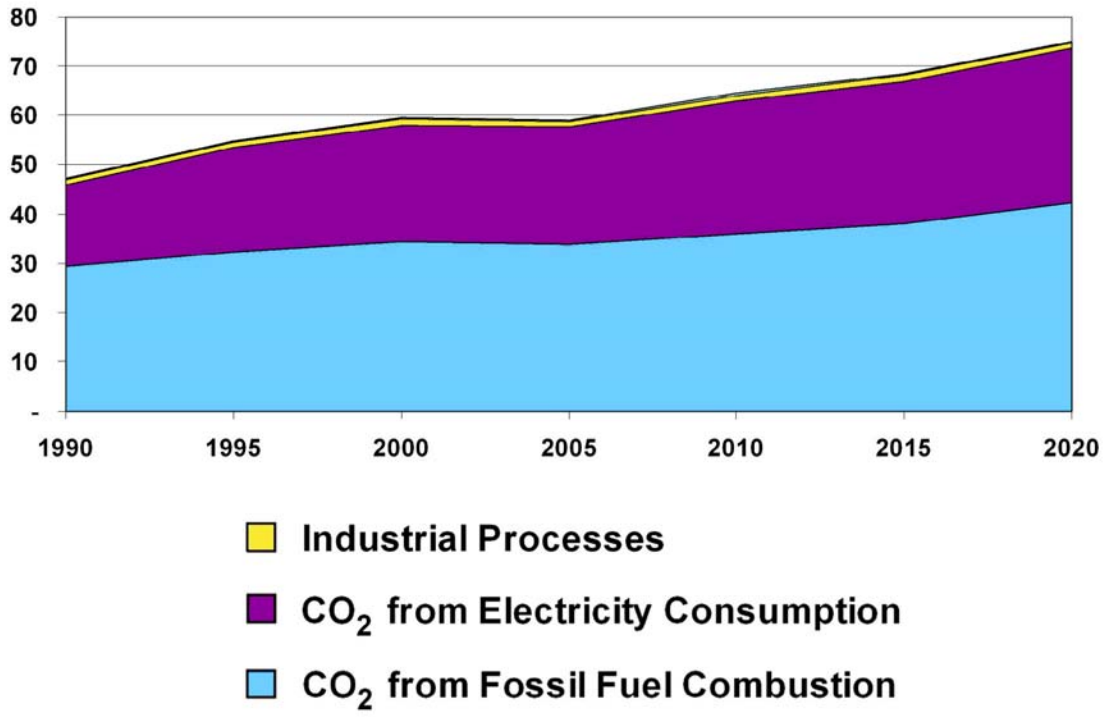
NOTE: Totals for 1990 through 2004 differ slightly from the detailed inventory (in Table 6) due to rounding differences.

[1] The fossil fuel combustion totals do not count in-state generation of electricity (this is a consumption-based inventory).

1.7 Emission Forecasts

Based on U.S. EPA forecasting tools and previously conducted sector-specific forecasts, the Oregon Department of Energy forecasts that Oregon's greenhouse gas emissions will grow by 30 $MMTCO_2e$, or 55 percent, in the worst case estimate from 1990 to 2020. That rate assumes no change from current practices (a "business as usual" estimate). In reality, it will probably grow less, although domestic reductions may be offset by increased emissions as production shifts overseas. Table 5 shows the forecast by sources of gases, and contrasts it with historical data. Table 5 also provides a hybrid inventory/forecast estimate for 2005.[47] Unfortunately, the full set of data necessary to complete the inventory for 2005 will not be available until early 2008.

Figure 20: Historical & Projected CO_2 Emissions (Million Metric Tons of CO_2)



(Emissions from Waste Combustion are too small to appear in Figure 20.)

Figures 20 (above) and 21 (next page) illustrate the projected future growth of greenhouse gas emissions. The relative contribution of electricity consumption as compared with the direct combustion of fossil fuels (particularly in the transportation sector) is highlighted in Figure 20. The overall contributions of each type of greenhouse gas through 2020[48] are plotted in Figure 21.

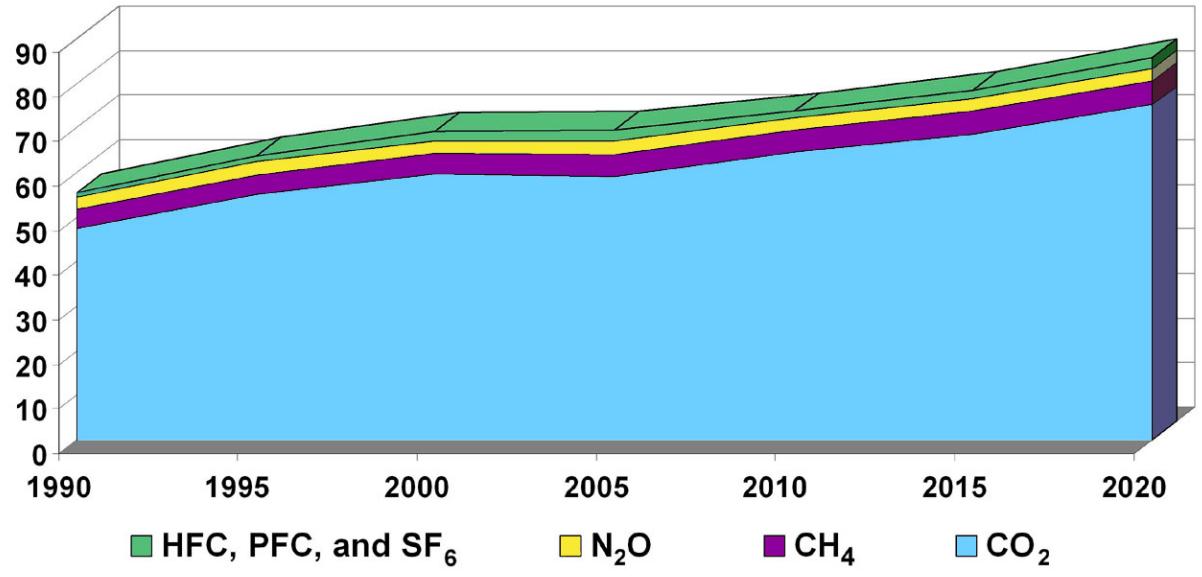
Electricity Forecast: For CO_2 emissions from electricity, the Department used a growth rate of 1.6 percent, which is a composite of Northwest Power and Conservation Council forecasts and forecasts in the integrated resource plans of Portland General Electric and PacifiCorp.[49]

[47] Inventory data derive from models, counts, or estimates that have been calculated or collected as a historical record. Forecast data derive from models or methodologies which use inventory data to project forward in time. Due to delays in federal data reporting, greenhouse gas inventories normally lag at least three years.

[48] Note that in the 2004 inventory the forecasts extended to 2025. The EPA projection tool (which was not available for the last inventory process) only provides estimates to 2020, so that is the current upper limit.

[49] The electricity forecast used in this inventory is the same forecast that was used in the 2004 inventory.

Figure 21: Projected Greenhouse Gas Emissions by Gas Through 2020 ($MMTC0_2e$)



Waste Methane Forecast: For methane emissions from waste, the historic trend is used as the starting point for projecting future growth in waste generation. Using Department of Environmental Quality and U.S. 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.

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 wastes, at about 46 percent when these forecasts were made, is assumed to hold constant, so not all of the added discards end up in landfills.[50]

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.[51]

Forecasts for Sectors other than Electricity and Waste: All other sectors are forecasted using the U.S. EPA projection tool, which is a relatively new addition to the State Inventory Tool (SIT) modules used for the majority of this inventory analysis. The EPA projection tool relies on the SIT inventory data to

[50] 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.

[51] The waste forecasts for this inventory use the same data and models as the 2004 greenhouse gas inventory.

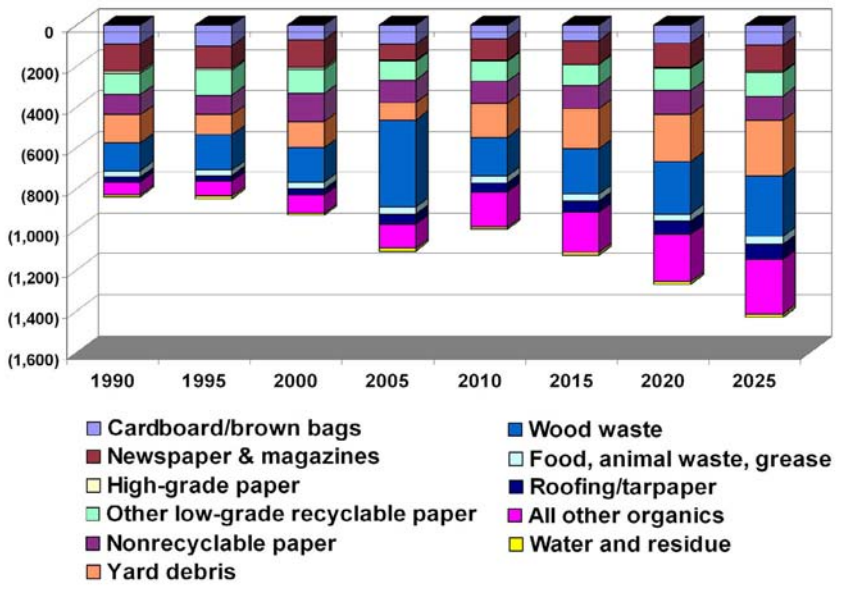
produce its forecasts by using economic and population indicator data as projection mechanisms. It also has a number of features particularly useful for the high global warming potential gases, where phase-out programs in place for many of those gases are included as part of the model. Where indicator data are not available, or where methods are not in place to predict future greenhouse gas emissions for certain sectors, the tool relies on linear forecasting methodology.

1.8 Net Emissions and the Oregon Inventory

The Oregon greenhouse gas inventory is a "gross" inventory process. Only emissions of greenhouse gases are counted and summarized in these pages. Some inventories also report on "net" emissions – which is the difference between the total emissions of greenhouse gases and carbon sinks (which sequester carbon out of the atmosphere). There are two major components to such an analysis. By far the largest potential sinks for Oregon are land use changes and forestry carbon dynamics (abbreviated "LUCF"). A secondary sink is carbon that is sequestered in landfills. However, due to substantial issues with forestry and land use data, Oregon is not yet ready to provide a net emissions total in its greenhouse gas inventory.

Waste Sequestration: Because food discards, yard trimmings, and paper do not completely decompose in the oxygen-depleted environment of a landfill, some of the carbon remains stored for long periods of time. Exactly how long is not known. This carbon storage would not normally occur under natural conditions, as discarded food, yard trimmings, and other plant-derived debris would normally be exposed to oxygen and thus degrade into carbon dioxide, thus completing the cycle of carbon between the atmosphere and the biosphere.

Figure 22: Thousand Metric Tons of Carbon (in CO_2e) Sequestered in Oregon Landfills



Because carbon storage in a landfill is caused by human intervention, it is counted as an anthropogenic sink, or sequestration. Carbon in plastic and rubber that remains in the landfill is not counted for sequestration, because it is of fossil fuel origin and does not represent carbon removed from the atmosphere. A comparison of how carbon is sequestered in Oregon landfills historically and in the future is presented in Figure 22.[52]

While all wastes containing biogenic carbon result in some sequestration, the landfilling of these wastes also results in methane generation. For some wastes (food, for example), methane generation is expected

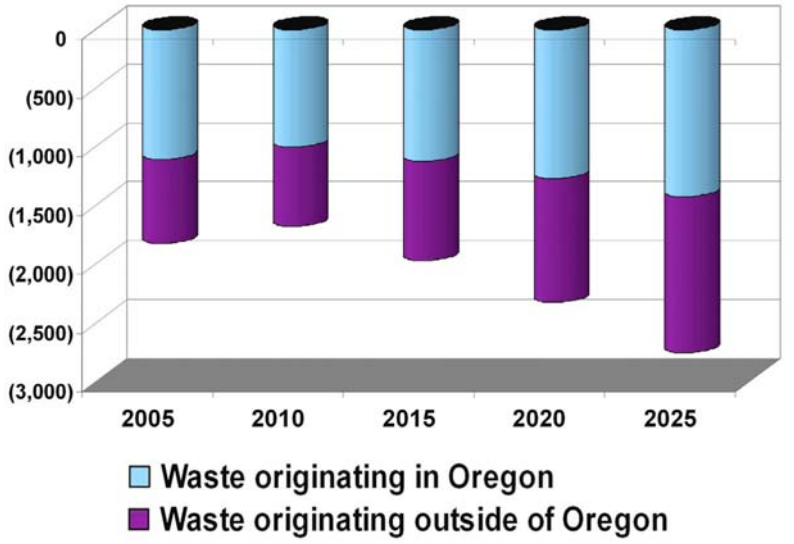
[52] The emission factors used in this analysis were slightly different in the years 2003-2005 than for data in previous years, and also for the projections from 2010 through 2025. This change in factors partly explains the discontinuity in both Figures 13 and 14 in the year 2005 numbers relative to the other years.

to exceed carbon storage. For other, slow-to-degrade materials such as lumber, newspapers and phonebooks, however, sequestration may exceed methane emissions.

Care must be taken when considering the sequestration benefit of landfilling wastes. Even though landfilling these materials results in a net increase in carbon storage, the alternative – recycling – typically has far greater benefits. This is because the greenhouse gas impacts of producing manufactured goods is typically many times higher than the greenhouse gas impacts of disposal. Recycling newspapers, for example, saves considerable quantities of natural gas in the newsprint production process – producing newsprint from old newspapers requires much less energy than producing newsprint from wood chips. So while landfill sequestration provides a counter-intuitive carbon benefit, it should not be used to promote landfilling of organic wastes.

Oregon's inventory estimates separate landfill sequestration for wastes originating in Oregon versus wastes coming to Oregon from out-of-state. (Oregon exports very little waste for landfilling in other states, but is a major recipient of waste from Washington.) Ownership of the sequestration benefits for waste originating in one state but landfilled in another will need to be resolved between the states. Resolving the ownership of waste-related emissions and offsets for waste crossing state lines will need to address both sequestration and methane emissions. To put this issue in perspective, Figure 23 demonstrates the substantial contribution of out-of-state imports of waste into Oregon landfills.

Figure 23: Imported Waste Impacts on Sequestered Carbon in Oregon Landfills (Thousand Metric Tons COe)



Forestry and Land Use: Reasonable estimates of the size of this sink are not currently available. The only data series currently available for use in this inventory process (from USDA) doesn't seem reasonable and creates more confusion than clarity. Without data from forestry and land use, however, it is not possible to create a correct net emissions figure for this inventory. Therefore, until reasonable data are available, Oregon will continue to offer only a gross emissions inventory as its official record of greenhouse gas emissions.

1.9 Emissions Associated with Consumption of Materials

The inventory presented here uses protocols established by the United Nations Framework Convention on Climate Change, the EPA, and regional arrangements among states and provinces made through initiatives such as the Western Climate Initiative. As has previously been noted, the current best practice in conducting state inventories is to utilize a "consumption-based" approach for the use of electricity within a state's boundary. In the future, however, it may be possible to extend these analyses to other sectors besides electricity. Cement, for example, is one area where future inventories may be able to use a similar "consumption-based" approach. The consumption of materials is another possibility.

For Oregonians to consume materials, those materials have to be produced. Production may result in energy, process, transport, agricultural, land change, and/or waste-related emissions. Many of these emissions occur out-of-state, and are not included in this inventory.

At the same time, while emissions from producing materials in Oregon are fully counted in the inventory, many of these materials are ultimately sold elsewhere. Production-related emissions are included in the commercial, industrial, agriculture, transportation, and waste sectors in Figures 18 and 19. Some – but not all – of these emissions are in fact associated with consumption of materials by Oregonians.

Lack of data makes completing an inventory that accounts for all of the embedded energy in the production and consumption of materials highly challenging. There are currently no widely-accepted methodologies or protocols for completing such an inventory. Correlating the results of such an approach with existing inventory protocols is even more difficult. Advancements in methodologies and data sets for both life cycle analysis and multiregional input-output modeling offer the potential for more robust analyses in the future. For now, it is worth acknowledging the implications of this omission.

1.9.1 Rough Estimate of Consumption-Based Emissions for Materials

Several very rough estimates demonstrate the significance of consumption-based emissions for material goods. Initial modeling by DEQ in support of the *Oregon Strategy for Greenhouse Gas Reductions* suggested that production-related emissions for goods consumed in Oregon in 2004 were roughly 7.1 $MMTCO_2e$ – or 11 percent (mostly) "above and beyond" the official inventory. However, this modeling significantly undercounted emissions, for several reasons.

- Production of several high-intensity materials (including cement and food) were not included in the model. By one estimate, the activities associated just with production of livestock products contribute 18 percent to worldwide anthropogenic greenhouse gas emissions.
- DEQ made the simplifying assumption that all overseas production had emissions intensities comparable to domestic production. Multiregional input-output modeling now suggests that the embodied emissions of imports (net, after subtracting exports) add *another* 15 percent to conventional counts of domestic emissions. Researchers at Carnegie Mellon University estimate that in 2004, 29 percent of CO_2 to satisfy household consumption in the U.S. (across all sectors) occurred abroad, a number that is growing rapidly as the trade gap widens and imports increasingly come from countries with high carbon intensity.

1.9.2 Implications

- The exclusion of most materials-related emissions tends to mask the significance of waste prevention, recycling, and "sustainable consumption" initiatives that aim to reduce the greenhouse gas impact of production and consumption of material goods. It also leads to unrealistically low estimates of the greenhouse gas impacts of all consumption activities in Oregon.
- Imports tend to be produced using less efficient processes and with higher emissions intensities. As imports increase in quantity, consumption-related emissions are expected to increase at a higher rate than production-related emissions.
- Policies that cause production to shift overseas may lead to an increase in net emissions. At the same time, the real increase in emissions associated with such a shift might be masked by an apparent decline in emissions as reported in the inventory.

Table 6: 2007 Revision and Update to Oregon Greenhouse Gas Inventory

Consumption-based Gross Emissions in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$) for 1990 through 2004

Emissions ($MMTCO_2e$)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Carbon Dioxide (CO_2)															
Direct Combustion															
Residential	2.038	2.186	1.896	2.415	2.353	2.220	2.474	2.371	2.460	2.789	2.752	2.765	2.777	2.664	2.584
Commercial	1.880	1.855	1.651	1.797	1.706	1.775	1.891	1.885	1.961	2.027	2.064	2.127	2.053	1.737	1.776
Industrial	5.308	5.513	6.190	6.565	6.501	6.924	6.716	6.662	6.338	7.618	7.068	6.932	7.167	6.474	7.317
Transportation	20.024	21.615	21.630	20.877	21.655	21.236	21.971	22.094	23.083	23.320	22.594	21.596	21.868	21.675	22.798
Electricity Consumption															
Residential	5.976	6.197	5.906	7.765	7.656	7.588	7.835	7.836	7.835	8.398	8.470	8.709	8.314	8.562	8.495
Commercial	4.398	4.512	4.592	5.676	5.888	6.000	6.069	6.405	6.403	6.935	7.111	7.372	7.058	7.474	7.394
Industrial	6.022	5.943	5.876	6.982	7.010	7.367	7.719	7.697	6.544	6.560	7.605	6.510	5.824	5.774	5.641
Transportation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.008
Other (non-specified use)	0.303	0.307	0.298	0.309	0.361	0.313	0.321	0.201	0.185	0.218	0.221	0.239	0.238	0.000	0.000
Industrial Processes															
Cement Manufacturing	0.216	0.225	0.228	0.196	0.214	0.207	0.360	0.379	0.399	0.457	0.447	0.429	0.430	0.370	0.422
Lime Manufacturing	0.068	0.091	0.096	0.140	0.147	0.157	0.172	0.156	0.171	0.160	0.145	0.098	0.074	0.077	0.097
Limestone & Dolomite Use	0.009	0.009	0.009	0.009	0.007	0.013	0.006	0.012	0.011	0.013	0.009	0.006	0.008	0.005	0.007
Soda Ash	0.031	0.030	0.031	0.031	0.031	0.032	0.032	0.033	0.033	0.032	0.032	0.032	0.033	0.032	0.032
Ammonia & Urea	0.077	0.076	0.080	0.073	0.077	0.080	0.089	0.080	0.082	0.081	0.074	0.058	0.075	0.066	0.072
Iron & Steel Production	0.704	0.704	0.704	0.704	0.704	0.704	0.704	0.811	0.747	0.640	0.750	0.573	0.440	0.429	0.429
Waste Incineration	0.274	0.274	0.270	0.273	0.320	0.310	0.304	0.297	0.289	0.252	0.267	0.276	0.289	0.222	0.315
Liming of Agricultural Soils	0.030	0.025	0.027	0.029	0.031	0.033	0.035	0.038	0.040	0.042	0.044	0.038	0.033	0.034	0.039
Total Gross CO_2	**47.358**	**49.562**	**49.485**	**53.841**	**54.658**	**54.958**	**56.699**	**56.956**	**56.581**	**59.542**	**59.652**	**57.758**	**56.680**	**55.603**	**57.427**

Emissions ($MMTCO_2e$)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Methane (CH_4)															
Stationary Combustion	0.100	0.102	0.097	0.110	0.103	0.103	0.112	0.104	0.095	0.097	0.100	0.138	0.136	0.137	0.144
Mobile Combustion	0.057	0.056	0.057	0.056	0.054	0.052	0.049	0.050	0.048	0.044	0.041	0.038	0.035	0.031	0.031
Natural Gas and Oil Systems	0.576	0.582	0.588	0.595	0.601	0.607	0.614	0.620	0.626	0.633	0.639	0.647	0.654	0.662	0.671
Enteric Fermentation	1.998	2.016	1.999	1.983	2.118	2.211	2.271	2.249	2.200	2.185	2.133	2.020	2.113	2.049	2.203
Manure Management	0.257	0.257	0.266	0.256	0.272	0.276	0.268	0.276	0.281	0.287	0.306	0.313	0.365	0.407	0.409
Burning of Agricultural Crop Waste	0.003	0.003	0.003	0.004	0.003	0.003	0.004	0.004	0.003	0.002	0.003	0.002	0.002	0.003	0.003
Waste in Landfills	1.036	1.041	0.991	0.979	0.961	0.930	0.983	1.039	1.076	1.087	1.119	1.168	1.196	1.257	1.294
Municipal Wastewater	0.191	0.197	0.201	0.206	0.210	0.214	0.218	0.222	0.225	0.228	0.230	0.234	0.236	0.238	0.241
Fruits & Vegetables Wastewater	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.006	0.007	0.007	0.007	0.007	0.007	0.007
Red Meat Wastewater	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Poultry Wastewater	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Pulp & Paper Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total CH_4	**4.229**	**4.264**	**4.211**	**4.199**	**4.334**	**4.408**	**4.530**	**4.574**	**4.565**	**4.574**	**4.582**	**4.570**	**4.748**	**4.794**	**5.005**

Nitrous Oxide (N_2O)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Stationary Combustion	0.108	0.106	0.095	0.096	0.097	0.097	0.105	0.106	0.097	0.095	0.100	0.097	0.086	0.084	0.086
Mobile Combustion	0.516	0.529	0.582	0.617	0.616	0.621	0.619	0.650	0.657	0.631	0.603	0.544	0.509	0.470	0.436
Nitric Acid Production	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manure Management	0.107	0.108	0.107	0.098	0.085	0.094	0.081	0.084	0.101	0.107	0.119	0.125	0.128	0.146	0.159
Agricultural Soil Management	2.063	1.961	1.908	2.248	1.841	2.082	2.302	2.134	2.231	1.899	1.965	2.008	2.076	2.038	1.987
Burning of Agricultural Crop Waste	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N_2O from Settlement Soils	0.057	0.055	0.057	0.056	0.062	0.061	0.066	0.072	0.071	0.053	0.040	0.058	0.082	0.094	0.090
Waste Incineration	0.023	0.023	0.023	0.023	0.024	0.024	0.026	0.027	0.028	0.028	0.027	0.029	0.030	0.032	0.033
Municipal Wastewater	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Total N_2O	**2.877**	**2.785**	**2.775**	**3.142**	**2.728**	**2.984**	**3.204**	**3.078**	**3.188**	**2.817**	**2.858**	**2.865**	**2.915**	**2.867**	**2.795**

Emissions ($MMTCO_2e$)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
High GWP Gases – HFC, PFC, and SF_6															
Ozone-Depleting Substance Substitutes	0.004	0.007	0.034	0.090	0.179	0.385	0.541	0.696	0.795	0.889	0.986	1.083	1.186	1.289	1.405
Semiconductor Manufacturing	0.291	0.291	0.291	0.364	0.401	0.496	0.551	0.632	0.767	0.836	0.783	0.598	0.628	0.627	0.679
Electric Power Transmission and Distribution System	0.430	0.411	0.402	0.391	0.363	0.331	0.311	0.282	0.223	0.228	0.223	0.204	0.187	0.179	0.175
Aluminum Production	0.317	0.270	0.128	0.281	0.250	0.256	0.270	0.272	0.279	0.280	0.195	0.191	0.000	0.000	0.000
Total HFC, PFC, and SF_6	**1.042**	**0.980**	**0.855**	**1.126**	**1.192**	**1.468**	**1.673**	**1.882**	**2.064**	**2.234**	**2.187**	**2.076**	**2.002**	**2.095**	**2.260**
Gross Emissions, Consumption Basis	**55.506**	**57.591**	**57.327**	**62.309**	**62.913**	**63.817**	**66.107**	**66.491**	**66.399**	**69.167**	**69.279**	**67.270**	**66.344**	**65.360**	**67.487**

Inventory Notes:
Data generated from the EPA State Inventory Tool (SIT) except for electricity consumption (ODOE) and waste (ODEQ).
Zeroes in some columns may mask emissions that are in the hundreds of metric tons and thus don't show up above.

An emerging consensus is for greenhouse gas inventories to attribute energy emissions to the jurisdiction in which the energy is consumed. The Western Regional Air Partnership and the Western Climate Initiative use this convention. Counting only emissions attributable to in-state power generation (but not power consumption) is also done in some instances, and is done by the federal government for national data and state-level reports. For purposes of comparison those data are below:

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Add In-state Electric Generation	1.795	3.610	4.513	4.309	5.453	2.725	3.197	2.700	6.189	6.221	7.339	8.520	6.375	8.048	8.029
Remove Electricity Consumption	(16.698)	(16.960)	(16.671)	(20.731)	(20.915)	(21.267)	(21.945)	(22.139)	(20.967)	(22.112)	(23.407)	(22.830)	(21.434)	(21.818)	(21.538)
Gross Emissions, Production Basis	**40.603**	**44.242**	**45.168**	**45.887**	**47.451**	**45.275**	**47.359**	**47.052**	**51.621**	**53.276**	**53.211**	**52.960**	**51.285**	**51.589**	**53.978**

Appendix 2: Interim Report of the CCIG

Date: January 8, 2007

To: Governor Ted Kulongoski

From: Mark Abbott and Ned Dempsey, Co-Chairs of the Climate Change Integration Group

RE: Interim Report from the Climate Change Integration Group

Oregon, as with every other state and nation, is on the precipice of a major crisis as a result of fundamental changes in our planet's environment. Impacts such as reduced mountain snow pack, rising sea levels and warming temperatures will grow in magnitude. Because steps taken today to address climate change will take many years to reach full effect, Oregon must act now to reduce its contribution to the problem by reducing locally generated greenhouse gases. The state must also begin now to prepare for the impacts of climate change that cannot be prevented. Finally, efforts must begin immediately to help local industries capture some of the projected $500 billion global market that will emerge in low carbon goods and services in response to the need to reduce greenhouse gas emissions. This document proposes a suite of initial actions aimed at helping the state prepare for the coming climate change crisis.

Over the next 50 years, levels of carbon dioxide in the Earth's atmosphere will likely exceed those experienced on the planet over the last several million years. Most of this increase will result from the burning of fossil fuels (energy production) as the human population and the global economy expands. An increase in carbon dioxide in the atmosphere will result in a warmer planet and alterations in global climate.

A warmer planet will result in dramatic changes seriously affecting Oregon and the world. Other states are moving forward with innovative policies relating to climate change. Oregon must act now to maintain its livability and to take advantage of the economic opportunities resulting from a carbon constrained economy. Oregon could lead the nation and the world in developing innovative policies and business investment models to combat changes in global climate.

In the near future, we will be operating under conditions that have not been experienced by human civilization before. Given that the carbon dioxide we release today will remain in the atmosphere for centuries, we must work both to dramatically reduce the amount of carbon dioxide we produce (mitigation) and to adapt to the changes in our climate (adaptation).

At the recommendation of your Advisory Group on Global Warming, you created the Climate Change Integration Group (CCIG) to develop a climate change strategy for Oregon that provides long-term sustainability for the environment, protects public health, considers social equity, creates economic opportunity and expands public awareness. The CCIG has representatives from a broad range of stakeholders including: public health, academia, the business sector, the forest products industry, and environmental advocacy.

The urgent need for adaptation strategies for Oregon – as well as the goals you set forth for Oregon to arrest the growth of greenhouse gas emissions by 2010, to reduce the greenhouse gas emissions to 10 percent below 1990 levels by 2020, and to reduce them to levels 75 percent below 1990 emissions by 2050 — have established the framework for our conclusions.

Your charge to the Climate Change Integration Group is to meet the following objectives:

1. **Develop a toolbox** of options for curbing and coping with climate change. The tool box includes prioritizing and implementing policy recommendations in the *Oregon Strategy for Greenhouse Gas Reductions;* assisting state agencies and other groups to incorporate climate change into their policies and programs, and making additional policy and program recommendations to achieve the goals of the strategy;
2. **Continually assess** the sensitivity, adaptive capacity, and vulnerability of natural as well as human economic and social systems to climate change in Oregon and prepare recommendations about how the state can become more resilient and prepare for unavoidable changes;
3. **Initiate and support research aimed at identifying management opportunities and strategies** for mitigation and adaptation, in collaboration with the Oregon University System; and,
4. **Educate Oregonians by** providing a clearinghouse for sharing information with citizens about climate change impacts and the opportunities in Oregon to address those impacts in an environmentally and economically sustainable manner.

This document provides the initial recommendations of the CCIG and outlines the group's proposals regarding how it will conduct its work in 2007. At the end of 2007, the CCIG will provide a comprehensive report back to you with an in-depth examination of the adaptation, mitigation, public education, and research components of this group's work and their relationship to the state's greenhouse gas strategies.

LEGISLATIVE ACTIONS

The CCIG met five times during 2006 and received presentations from several state agencies, the wine sector, the ski industry and others describing the potential impacts of climate change on their interests and the state. Based on those presentations and the group's deliberations, the following are proposed as initial recommendations for near-term action (legislative or otherwise).

- Support legislative adoption by resolution or as part of a broader climate change legislative package in the 2007 legislative session your previously announced state greenhouse gas reduction goals. The goals adopted in 2004 by the *Oregon Strategy on Greenhouse Gas Reductions* may need to be revisited based on new scientific data.
- Appoint a special committee composed of CCIG members and outside experts every five years, beginning in 2007, charged by the Governor to evaluate the current understanding of climate change science relative to the state's emission reductions goals and make a determination if those goals should be modified in response to new information. The schedule should generally be

coordinated with the release of the Intergovernmental Panel on Climate Change (IPCC) scientific assessments.

- Permanently establish the Climate Change Integration Group, preferably by legislation, to serve the needs of Oregonians as climate change becomes an even more pressing issue in the near future and provide the means for funding expenses of the CCIG in a manner similar to other state advisory bodies to allow for a diverse geographic representation at meetings and events.
- Dedicate funding to establish a climate change research center for research (environment, public health, economic, etc.) through the Oregon University System, focusing on both adaptation and mitigation strategies for both natural and human ecosystems in response to climate change in Oregon.
- Dedicate funding to establish an ongoing education, communication and outreach program on climate change. This is vital to assure that investments in research and policy measures will be translated into on-the-ground results.
- Establish and fund a program of technical assistance to assist local governments to devise climate change action plans including policy, practices, and programs specific to the concerns of Oregon communities.
- Establish an ongoing tracking system to report on progress in achieving climate change goals, including the establishment of an easily comprehensible graphical reporting format.
- Direct the Department of Administrative Services to coordinate with the CCIG on the state agency greenhouse gas inventory process you established by executive order for creating a greenhouse gas tracking and reporting mechanisms within state agencies.
- Direct relevant state agencies, including DAS, DOE, DEQ, and ODOT to establish an interagency climate change team, and direct those agencies to prepare a progress report on mitigation measures undertaken as part of the *Oregon Strategy for Greenhouse Gas Reductions* on a biannual basis. In addition, a brief, graphical summary of progress should be made available on-line at an appropriate location on the Oregon Department of Energy's web page and on the Sustainableoregon.net web page.
- Encourage a non-governmental organization to develop and publicize a catalog of voluntary mitigation actions being taken by Oregon corporations and organizations.
- Continue efforts to develop a regional dialogue with other western states on greenhouse gas reduction strategies.
- Identify opportunities to work with federal agencies and Oregon's congressional delegation on climate change programs and national climate change policy development.
- Conduct an updated and more thorough assessment of the economic impacts of climate change in Oregon. The impact of the recent "Stern Report" in the United Kingdom demonstrates the momentum that can be built from pragmatic economic-focused research.
- Support research that contributes to the work of the Carbon Allocation Task Force by investigating the macroeconomic effects of Oregon's carbon policy, with a particular focus on unintended policy consequences — such as the transfer of carbon-intensive activities across state borders — that may result from inappropriate policy choices.
- Direct the Department of Human Services (DHS) to coordinate the development of a report on the public health effects of climate change in Oregon, including recommendations for proactive public health measures and further research.

WORK PLAN FOR 2007

The Climate Change Integration Group has set the following goals for its work in 2007 to prepare the group for its full report to the Governor due at the end of 2007:

- Develop specific recommendations for climate change adaptation strategies, processes, and policies for government agencies, private industry, and the general public.
- Evaluate and propose economic development strategies for expanding the local production and sales of low-carbon goods and services.
- Develop an education and communication strategy on climate change in Oregon to build public will to make the necessary changes to mitigate climate change and adapt to its effects. Create material to support the *Oregon Strategy for Greenhouse Gas Reductions* suitable for broad-based dissemination and targeted audiences.
- Hold a workshop of climate change experts in early 2007 to fulfill four primary goals: to update the understanding of economic, social, health and ecological climate change impacts on Oregon; to develop a series of socioeconomic scenarios involving key sectors of Oregon's economy; to address key mitigation measures; and to raise awareness among Oregonians about the challenges and opportunities presented by climate change.
- Create a state website on climate change in Oregon that will be a clearinghouse of climate change information and also link to resources and other websites.
- Develop suggestions for a research agenda on climate change for the Oregon University System and, to a lesser degree, for state agencies and the private sector.
- Develop and implement a measurement and monitoring system for the *Oregon Strategy for Greenhouse Gas Reductions.*
- Evaluate the *Oregon Strategy for Greenhouse Gas Reductions* and propose additional measures for reducing greenhouse gasses necessary to achieve the state's greenhouse gas reduction goals (towards the latter half of 2007).

CONCLUSION

Your actions in creating the *Oregon Strategy for Greenhouse Gas Reductions* established Oregon as one of leaders in mitigating the impacts of climate change. Your establishment of the CCIG has now expanded these efforts to include the development of adaptation strategies as part of a comprehensive portfolio for Oregon. The urgency of these efforts cannot be overemphasized. There are both opportunities and risks, but our continued prosperity as well as our heritage of environmental stewardship demand that we begin now. We cannot simply wait for an uncertain future to make itself manifest. Our grandchildren will see a planet that is far different than the one we have experienced. We owe it to them to begin the journey now.

Appendix 3: Progress of CCIG Relative to Goals Set Out in CCIG Interim Report

This is a brief look at the CCIG Interim Report that was submitted at the end of last year and what actions were completed through passage of HB 3543 or have otherwise been addressed.

✓ Completed, addressed, or completed in this final report.
? Events have transpired such that the item may no longer be relevant.
— Not completed, not funded, or insufficient resources to complete.

LEGISLATIVE ITEMS

✓ Support legislative adoption in the 2007 legislative session and the state greenhouse gas reduction goals.	Completed with passage of HB 3543.
? Appoint a special committee to evaluate the current understanding of climate change science relative to the state's emission reduction goals, and possibly suggest changes.	Codification of goals in law makes changing them extremely difficult.
✓ Permanently establish the Climate Change Integration Group, preferably by legislation…	HB 3543 creates Global Warming Commission.
— and provide the means for funding expenses of the CCIG in a manner similar to other state advisory bodies.	No additional funding provided.
✓ Dedicate funding to establish a climate change research center for research through the Oregon University System.	$180,000 allocated in HB 3543 as seed money.
— Dedicate funding to establish an ongoing education, communication and outreach program	No funding allocated.
— Establish and fund a program of technical assistance to assist local governments to devise climate change action plans including policy, practices, and programs.	No funding allocated.
✓ Establish an ongoing tracking system to report on progress in achieving climate change goals.	Required reporting to Global Warming Commission.
? Direct the Department of Administrative Services to coordinate with the CCIG on the state agency greenhouse gas inventory process	State agency inventory report already completed by DAS.
✓ Direct state agencies to establish an interagency climate change team, and direct those agencies to prepare a progress report on mitigation measures.	Global Warming Commission seems to have this authority and agency heads on GWC comprise *de facto* interagency climate change team.
— Encourage a non-governmental organization to develop and publicize a catalog of voluntary mitigation actions being taken by Oregon corporations and organizations.	This is one of the roles that the Climate Registry may end up playing in Oregon.

✓ Continue efforts to develop a regional dialogue with other western states on greenhouse gas reduction strategies.	Fulfilled by Oregon's role in Western Climate Initiative (WCI).
✓ Identify opportunities to work with federal agencies and Oregon's congressional delegation on national climate change policy development.	Ongoing
— Conduct an updated and more thorough assessment of the economic impacts of climate change in Oregon.	No funding allocated.
— Support research that contributes to the work of the Carbon Allocation Task Force by investigating the macroeconomic effects of Oregon's carbon policy	Necessary for WCI work, but no funding currently exists.
— Direct the Department of Human Services (DHS) to coordinate the development of a report on the public health effects of climate change in Oregon.	Presumably could be addressed by Global Warming Commission authority.

WORK PLAN ITEMS

✓ Develop specific recommendations for climate change adaptation strategies, processes, and policies for government agencies, private industry, and the general public.	Addressed by CCIG final report to some degree.
— Evaluate and propose economic development strategies for expanding the local production and sales of low-carbon goods and services.	Not addressed by CCIG to date, although not in the charter of the CCIG.
✓ Develop an education and communication strategy on climate change in Oregon.	Included as chapter in CCIG final report.
— Create material to support the *Oregon Strategy for Greenhouse Gas Reductions* suitable for broad-based dissemination and targeted audiences.	ODOE applied to US EPA for grant to fund materials, but that grant was not funded.
— Hold a workshop of climate change experts in early 2007.	Initial proposal for OSU-led workshop failed to advance. Due to lack of resources, workshop didn't take place.
✓ Create a state website on climate change in Oregon that will be a clearinghouse of climate change information.	New climate change web portal and climate change listserv substantially complete.
✓ Develop suggestions for a research agenda on climate change for the Oregon University System and…	Addressed in CCIG final report.
— to a lesser degree, for state agencies and the private sector.	Not addressed.
✓ Develop and implement a measurement and monitoring system for the mitigation measures in the *Oregon Strategy*.	Mitigation chapter includes status report on measures.
✓ Evaluate the *Oregon Strategy* and propose additional measures for reducing greenhouse gas emissions.	Transport-related items included in CCIG final report. No additional items added.

Appendix 4: Status of Deferred Measures from 2004 Global Warming Advisory Group

The Governor's Advisory Group on Global Warming considered a wide range of potential actions to address climate change. The deferred actions listed below were not included in the 2004 report to the Governor, *Oregon Strategy for Greenhouse Gas Reductions*, because they required further evaluation or development. The numbers assigned to the Deferred Measures are unique to this list.

The numbers for measures included in the Recommended Actions list in the 2004 report are unique to that report and do not correspond to those listed below.

Energy Efficienct Measures Deferred

	Measures	GHG Savings MMT CO_2 in 2025	Technical Feasibility and Cost Impacts	Status
EE-5	Adopt OR goal of NWPPC efficiency target plus 20%	1.32	Potentially cost effective under cap-and-trade	SB 838 authorizes expenditures for energy efficiency measures by PGE andPacifiCorp. Regulated by the Oregon Public Utility Commission (OPUC).
EE-7	Advocate with BPA & Oregon COUs to meet NWPPC Goal +20%	Included in EE 5	Not Initially	BPA and Oregon electric consumer owned utilities (COUs) have been working on new 20-year power-sale contracts. These contracts will likely place the responsibility for meeting load growth on the COUs. This will provide better incentives for Oregon COUs to actively pursue energy efficiency and renewable generation, as their alternative would be wholesale power at market prices.
BASE EE-10	**BASE CASE (NWPCC)** Funding beyond ETO's current 2012 sunset date	[Included in base case (EE1)]	Is cost-effective	SB 838 extends the Public Purpose Charge, source of funding for ETO, through 2025.
EE-17	Inter-generational state bonding to finance EE programs and investments. Expand SELP bonding limits, extend terms of loans			Current program has flexibility. No statutory changes needed. Term length and total bonding limit have never been binding constraints on loan program. Concern/ intent unclear.
EE-18	Advocate for inter-generational federal bonding to finance EE programs/investments			State advises and advocates for sound federal legislation.
EE-19	Transmission/Distribution System efficiencies			Net metering rules adopted by OPUC. Line losses are being considered in the Western Climate Initiative (WCI) proceedings.

EE-20	"Smaller Houses" initiative			No action
EE-21	Allow regulated utilities to invest in (and earn a return on) customer energy efficiency measures, SB 1149 notwithstanding			SB 838 authorizes expenditures for energy efficiency measures by PGE and PacifiCorp. Regulated by the Oregon Public Utility Commission (OPUC).

Generation Measures Deferred

	Measures	GHG Savings MMT CO_2 in 2025	Technical Feasibility and Cost Impacts	Status
Gen 3	**Gen 3A:** State Renewable Portfolio Standard (new renewable content) • 15% of 2025 load • 25% of 2025 load	2.78 6.96	Potential near-term rate increases offset by long-term cost-effective power supplies, price stability, other benefits; 15% likely feasible; 25% maybe not.	SB 838 requires 1) Utilities servicing at least 3% of Oregon's electrical load to meet 25% from renewables by 2025. Interim targets: 5% by 2011, 15% by 2015, and 20% by 2020. 2) Utilities serving less than 1.5% must meet 5% from renewables by 2025. 3) Utilities serving between 1.5% and 3% must meet 10% by 2025. SB 812 includes PUD statute changes.
Gen 3	**Gen 3C:** For Oregon IOU's, insulate ratepayers from cost risks associated with potential future carbon regulation affecting new resource acquisitions.	2.35	Little early impact on rates, later impact depends on CO_2 regs.	SB 838 has cost cap to limit cost impacts. OPUC proceeding UM1302 will conclude in early 2008.
Gen 5	Advocate with OPUC to insulate IOU ratepayers from cost risks associated with potential future carbon regulation.	2.35	Little early impact on rates; later impact depends on CO_2 regulations	See Gen 3C above.
Gen 6	State Carbon Tax on CO_2 content of electricity, natural gas and stationary oil use	depends on level	Major costs increases. Major competitiveness issues for Oregon businesses.	Not yet ready for consideration. Western Climate Initiative (WCI) is examining multi-sector cap-and-trade. WCI partners will release design recommendations for a regional cap-and-trade program in August 2008.
Gen 9	Major/intergenerational state bonding to finance renewable programs and transmission investments			Current program has flexibility. Concern/ intent unclear.

Gen 10	State funds for Pacific Northwest regional "incubator" to demonstrate promising technologies, e.g.: • Generation • Transmission efficiencies • Controls • Integration services • Resource (e.g. wind) evaluation • Distributed Generation	Scale depends on level of other West Coast States funds	Fiscal Impacts	SB 581 provides support for industry development through production incentives and infrastructure and permitting processes for research and development of ocean wave energy for $5.2 million.
Gen 12	Nuclear Power		Relies on technology advances not presently available commercially. Security costs and risks of plutonium-reliant technology are potentially severe.	Not allowable under Oregon law.
Gen 13	Create an Oregon GHG Registry (or collaborate with an existing registry) to enable mandatory reporting of GHG emissions by utilities and major commercial emitters. If Oregon proceeded with this measure, linking it to cap-and-trade regime (such as that proposed in Measure Gen 3B)	2.78 6.96	Increased costs in rates. 15% likely feasible; 25% maybe not.	Oregon DEQ advisory committee is convened. Rulemaking in early 2008. Oregon jointed The Climate Registry
Gen 14	If a Carbon Content or similar constraint is adopted, consider whether additional low-income assistance may be appropriate to help manage front-loaded costs of compliance			WCT process will consider measures to mitigate impacts to low income consumers
Gen 15	ODOE should work with BPA and other PNW states, and a Regional Transmission Organization (RTO) if appropriate, to seek WCI transmission loss reductions of ± 50% by 2014 [Foley]			No NW RTO has been formed. Transmission losses will be considered as part of effort.
Gen 16	Create Distributed Generation resource chain by cleaning up and linking together operationally the diesel genets currently in place and used as backup power sources			PGE has a program that uses 50 MW of standby diesel generation as a peaking resource.

Transportation Measures Deferred

	Measures	GHG Savings MMT CO_2 in 2025	Technical Feasibility and Cost Impacts	Status
TRAN 16	Grow I-5 Corridor West Coast High-Speed Rail Service with more frequent and convenient service	TBD	Technically feasible, but significant costs for train(s)	No additional monies appropriated by the legislature for additional service since 2004. Currently have 2 roundtrip trains and 2 roundtrip buses. Oregon Rail Plan (2001) calls for 5 or 6 roundtrip trains by now. Two significant developments: 1) In 2007 session, the Legislature authorized $2 million for a multimodal transportation study – raised through Connect Oregon II program fees; 2) The 2007 Legislature established the Passenger Rail Transportation Account to be funded by customized registration plate fees (enough for 1 of 2 trains – the other one is funded from general fund). One roundtrip train costs about $5 million to operate per biennium. In general, buses now pay for themselves. What is needed: 1) Dedicated funding streams to pay for operation of up to 6 roundtrip trains, and 2) Capital improvement money to buy new trains and some line capacity improvements.
TRAN 17	Create Transportation emissions GHG "cap & trade" within PDX "bubble" (Other "bubbles"?) or include Transportation GHG emissions within a larger cap&trade mechanism if available	Unknown	Demonstration models are being analyzed on East Coast - TBD	The Western Climate Initiative (www.westernclimateinitiative.org) is designing a market-based mechanism to help achieve the adopted reduction goal of 15% below 2005 levels by 2020 (to be complete by August 2008). The WCI is considering including transportation sources in this mechanism.
TRAN 18	State Bonding to Finance Efficient Transportation Infrastructure	Unknown	Unknown	Unclear. No action.
TRAN 19	Port of Portland and other Oregon airports with common carrier service negotiate agreement with airlines serving PDX to establish and meet ground-use fuel efficiency goal (e.g., reduced idling).	Small	Technically feasible, low cost, PDX has begun this effort already.	No action
TRAN 20	Develop and adopt new GHG Goal for Oregon's Land Use law	Medium to Large	Technically feasible and should be cost-effective in long run	Addressed in 2007 Climate Change Integration Group report

TRAN 21	Set and meet goals for reduced diesel consumption by ships in port (shore power)	Small	Technical and cost difficulties loom large, may preclude early action here absent broader federal or global attention to this GHG source.	No report
TRAN 22	Convert Tri-Met, other bus transit fleets to hybrid or equivalent Low Emissions technology	Small	Feasible subject to availability of vehicles from manufacturers	Tri-Met: B5, electric light rail Cherriots (Salem-Keizer): 35 B20, 45 more compressed natural gas 14 EPA 2007 specs clean diesel on order Corvallis Transit: All B20 Lane Transit District: Testing B15 with 10 of 115 buses Umpqua Transit: (Roseburg) Problems with biodiesel for 13 older buses. Resumed diesel use. Rogue Valley: 15 compressed nat. gas, 8 diesel

Materials Measures Deferred

	Measures	GHG Savings MMT CO_2 in 2025	Technical Feasibility and Cost Impacts	Status
MW 2	Provide grants to increase edible edible food rescue (waste prevention/reuse); and, if feasible, provide incentives to capture multiple benefits	0.003[6,9]	Feasible. Costs would be about $4 million in grants over 20 years.[10]	No new initiatives from DEQ. However, DEQ continues to support edible food rescue operations through its solid waste reduction grants program. Six grants for edible food rescue totaling $181,000 were awarded in 2004-2007. Oregon Food Bank Network and other organizations are expanding food rescue using private donations.
MW 5	Provide incentives to stimulate development of agricultural plastics recovery/recycling infrastructure, and stimulate market demand. Determine if collaboration with WA, CA will stimulate market.	0.021[11]	Feasible. Costs are unknown, but potentially in the range of $500,000/year.	Business Energy Tax Credits and a state Energy Loan through ODOE enabled Agri-Plas (Marion County) to expand its plastics recycling business. No new action by DEQ.
MW 6	Require construction & demolition debris loads sorting prior to disposal: Metro, Lane & Marion wastesheds only	0.036	Feasible, but highly dependent on strong market demand for recyclables as well as energy recovery. Costs are unknown.	Metro Council in August 2007 adopted an ordinance requiring conformance to new guidelines by disposal facilities accepting dry waste originating from the Metro region. No more than 15% of waste sent to disposal can be pieces of wood, cardboard, or scrap metal above certain sizes. No requirements in Lane or Marion counties.

MW 7	Require all dry waste loads to be sorted prior to disposal: (Metro wasteshed only)	0.022[12]	Feasible, but highly dependent on strong market demand for recyclables as well as energy recovery. Costs are unknown	See MW-6, above. Metro's ordinance only targets construction/demolition wastes, not other dry wastes. No other action.
MW 8	Require businesses in certain areas to recycle specific materials	0.26	Feasible. Costs are unknown, but likely cost increases in some areas.	In progress. In November 2007 Metro Council directed staff to draft an ordinance mandating business recycling. No mandates elsewhere.
MW 9	Ban disposal of recyclable paper	0.33	Feasible, but costs are unknown.	No action
MW 14	Mandatory recovery of food wastes from larger businesses in Metro, Lane, and Marion wastesheds	0.11[6,13]	Feasible, cost to local governments (and DEQ) are unknown.	No action
MW 15	Implement combined residential food & yard debris collection and composting in cities with greater than 10,000 population in Metro, Lane, and Marion wastesheds	0.009[6,13]	Feasible. Costs are unknown.	Portland City Council adopted the Portland Recycles! Plan in August 2007. The Plan calls for weekly collection of combined residential food and yard debris in carts. The City hopes to implement this change in 2009 (contingent on a local composting facility being sited). Some other cities are considering a similar change.

Biological Sequestration Deferred

	Measures	GHG Savings MMT CO_2 in 2025	Technical Feasibility and Cost Impacts	Status
Bio-Seq 2	Straw as Biomass Energy for Willamette Valley Grass Seed Production Systems	0.0 MMT per year	Power generation on a farm conversion scale is technically feasible and avoids inefficient delivery of electricity to farms. Investment costs in the development/ application of on-site farm conversion (straw to energy) technology.	Straw residue from grass seed production is eligible for incentives under HB2210. ODA, ODOE and Seed Growers Association completed an assessment in Fall 07 of annual volumes by variety. Working with 3 potential cellulosic ethanol developers.

Bio-Seq 6	Adopt Policies and Programs to Place Greater Emphasis on Conservation and Restoration of River Floodplain and Natural Habitats in the Willamette River Basin	1.7 MMT per year	Some risk in the degree of success in restoring forest habitats due to technical problems. Opportunity costs from development forgone higher than for Bio 5 Measure (Retain Land Use Controls). Direct costs include cost of forest restoration and management and the cost of compensating landowners for increased conservation of floodplain and other natural habitats.	This measure was based on work conducted for the Willamette River Basin Planning Atlas. The idea has its roots in the Willamette Initiative. In general, the Willamette River Partnership is working in this regard. The Partnership is active in developing water quality trading programs and markets for other ecosystem services designed to result in implementing projects consistent with this measure.

Government Operations Measures Deferred

	Measures	GHG Savings MMT CO_2 in 2025	Technical Feasibility and Cost Impacts	Status
GOV/ OM 10	Oregon's Investment Council should add investment criteria that will employ investment capital (e.g., PERS) to assist in meeting Oregon's GHG goals.			No action
GOV/ OM 11	Oregon should establish a $/Ton "externality" adder for all state contracts (i.e., require a CO_2 impact calculation for all such contracts)			No action

Appendix 5: Principles from 2004 Oregon Strategy for Greenhouse Gas Reductions

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.

Excerpted from pages 7 and 8 of Oregon Strategy for Greenhouse Gas Reductions.

Appendix 6: An Informal Survey of Coastal Local Government Officials on Needs Related To Climate Change

At a workshop on climate change conducted on October 25, 2007 for local government officials in Oregon's coastal jurisdictions, the Oregon Coastal Management Program conducted an informal survey. Workshop participants were asked to respond to a single open-ended question:

What do cities and counties need fr om state and federal agencies r elated to climate change?

The survey resulted in 43 responses. Analysis of the responses shows that they can be separated into several categories. Some responses are in the form of a question or concern, but the rest indicate a specific need for some kind of state or federal agency action. The categories of local government needs apparent in the survey responses are defined and interpreted as follows:

Data and information: Data and/or information to better understand or predict the likely effects of climate change on coastal communities are needed.

Guidance: Materials to assess or improve local governments' ability to respond to the effects of climate change are needed.

Leadership: Political leadership to support local initiatives is needed.

Funding: Funding to assess vulnerability, develop adaptation plans, or to implement adaptation measures.

Outreach: Informational materials for the general public and elected officials about climate change and the need for action are needed.

Infrastructure: Structural measures are needed to mitigate the effects of climate change on coastal communities.

Question or concern: Survey response is a question or concern; no specific need was noted. Each response stated in the form of a question or concern has also been interpreted as falling within one of the other categories.

Although the question was not explicitly asked, and the responses do not specifically indicate such, in general, the survey responses reveal that most of those attending the workshop believe that global climate change is real, and that the effects of climate change will require some action on the part of local government. In numerical terms, the survey responses were as follows:

- ➔ Half of the responses (21) indicate a need for data and information; many of these responses specify a need for information about the effects of climate change at the community or watershed scale.
- ➔ Nearly one quarter (9) of the responses highlight the need for outreach efforts and/or materials.

- ➔ One tenth (4) of the responses indicate a need for guidance materials on preparing for the effects of climate change.
- ➔ Another one tenth (4) indicate a need for funding to plan for or implement response measures.
- ➔ Three responses call for state-level leadership.
- ➔ Two responses indicate a need for infrastructure to protect coastal communities from the effects of climate change.

Table 7 lists all the survey responses and the categories into which each response was placed.

Workshop participants were also encouraged to write down questions during the workshop presentations, so follow-up information could be provided in the event there wasn't time at the workshop for doing so. Three questions were submitted, but were not raised during the workshop:

> ***What changes in the Earth as a whole do we see which may make reference to the past a poor predictor of the future?***
>
> ***Are trends in Oregon climate different than trends in other parts of the world, or Earth as a whole?***
>
> ***What was the maximum stand in sea level during past inter-glacial periods compared with today?***

Table 7: Responses to the question "What do cities and counties need from state and federal agencies related to climate change?", and categories of responses

Survey response	Data and/or Information	Guidance	Leadership	Funding	Outreach	Infrastructure	Question or Concern
What will over building do to the coast line?	X						X
How would you stop PUDs (lots of homes/planned unit developments) going in along the coast?		X					
Regional or community-specific information regarding effects of global warming/ climate change	X						
Recommended course(s) of action to mitigate effects of sea level rise and other climate change concerns		X					
Grant programs to prepare community plans to address climate change.				X			
Want to know the possible scenarios that might result from climate change.	X						
Access to the latest climate change scientific data and how the Oregon Coast may be affected.	X						
Technical support to help determine how the ocean levels will change — which properties will be hit the most.	X						

Survey response	Data and/or Information	Guidance	Leadership	Funding	Outreach	Infrastructure	Question or Concern
What direction of tech [standards] can we add to our code to help? Roof top gardens – more trees?		X					
Impact of climate change on coast	X						
What/how will climate change impact sea level/flood elevations/coastal erosion?	X						
What are the changes in ocean temperature expected to be?	X						
Effects on water resources	X						
Effects on weather and ocean impacts	X						
Effect on energy resources	X						
In general — what are all the possible impacts?	X						
Estimates of beach narrowing.	X						
Effects of shoreline armoring in regards to sea level change	X						
Concern: Changes in frequency and intensity of storms and the effect that has on design standards and other aspects of planning.	X						X
Concern: Changes in ocean conditions causing changes in productivity and species composition.	X						X
Concern: Sea level rise, changes in rainfall altering salinity and other aspects of estuarine habitat.	X						X
Concern: Change in climate may introduce new diseases and pests to the area.	X						X
Will local governments need to change zoning codes to address effects of climate change — e.g., larger setbacks from ocean resources?		X					X
An informational brochure for the public and educational information for decision-makers would be helpful to inform communities about effects of climate change.					X		
White paper explaining that climate projections are based on modeling, and expressed by bureaucrats on IPCC, are nowhere close to a scientific consensus and that even if close to useful would take centuries to occur.					X		
Also that south coast is rising, due to tectonics, faster than rise of sea level.					X		
Simplified scientific data to explain to the public the necessity to take action on this topic.	X				X		
Educational component in the school system.					X		

Survey response	Data and/or Information	Guidance	Leadership	Funding	Outreach	Infrastructure	Question or Concern
What is the level of confidence around the estimates of possible sea level change and air temperature changes?	X						X
Effect communication with the press and public regarding how much impact is due to "man" and how much is normal processes — if possible.					X		
Concerted political action.			X				
Direct state actions to reduce greenhouse gasses.			X				
Financial assistance to local governments to prepare and implement plans to reduce greenhouse gasses.				X			
High priority for public education efforts.					X		
Funding to do local assessments of vulnerability of infrastructure — sewer, especially.				X			
Stormwater overflow during flooding from rains.	X						X
Tsunami alert — timeframe for evacuation.					X		X
Structural protections from gales.						X	
Levee reinforcements.						X	
Grants to apply for additional support to make plans.				X			
Unified message.			X		X		

Appendix 7: Charter of the CCIG

Governor's Climate Change Integration Group

CHARTER

May 5, 2006

1. Background

Governor Kulongoski has committed Oregon to reducing its greenhouse gas emissions in cooperation with the governors of California and Washington through the West Coast Governors' Global Warming Initiative. He established the Governor's Advisory Group on Global Warming in 2004 to develop a state strategy to complement the regional effort.

The Advisory Group issued its recommendations to the Governor in the *Oregon Strategy for Greenhouse Gas Reductions* (2004). The *Oregon Strategy* demonstrates that the means to reduce greenhouse gases are at hand or within technological reach and could be achieved through investments that can generate net economic returns over time and that can help Oregon businesses to stay competitive in a world moving to greenhouse gas limits.

The Governor's Advisory Group recommended a suite of policies and measures to reduce Oregon's greenhouse gas emissions and recommended goals to guide their implementation. Governor Kulongoski endorsed the goals and the key recommendations of the Advisory Group.[53] The Governor has taken significant actions to implement the recommendations, including (1) adopting the report's proposed carbon reduction goals (arrest increases by 2010; reduce emissions to 10 percent below 1990 levels by 2020; and reduce emissions to 75 percent below 1990 levels by 2050); (2) signing into law new appliance efficiency standards; (3) working with the Environmental Quality Commission to adopt greenhouse gas emission standards for vehicles; and (4) creating a task force for designing a carbon allocation standard for greenhouse gas emissions from electricity use and other sectors. There are numerous other actions that are also underway to implement the recommendations.

The Governor is now establishing the Climate Change Integration Group to continue and expand on the work of the Advisory Group. The Governor's charge to the Climate Change Integration Group is: "to develop a climate change strategy for Oregon that provides long-term sustainability for the environment, protect public health, consider social equity, create economic opportunity and expand public awareness."

[53] See "Environmental Principles and Priorities: Global Warming and Energy" at www.governor.oregon.gov/Gov/GNRO/global_warming_energy.shtml

Oregon's strategy is first based on science. Almost all scientists with the relevant expertise now believe that the Earth is warming, that humans are affecting climate, and that continued unchecked climate change will seriously affect the quality of life of people everywhere. The international group of thousands of scientists with expertise in climate matters, the Intergovernmental Panel on Climate Change, or IPCC, issues a periodic report that summarizes what is known about climate change. In its 1995 Second Assessment Report, the IPCC concluded: "the balance of evidence suggests that there is a discernible human influence on global climate." In 2001, the IPCC's Third Assessment Report concluded, "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities." The upward trajectory of average global temperatures continues, with nine of the 10 hottest years in the last 150 having occurred in the last 10 years (1996-2005). The findings of the IPCC have been endorsed by every credible independent assessment conducted by reputable scientists, including in 2001 by the U.S. National Academy of Sciences.[54]

In 2004 a group of scientists from the Pacific Northwest convened at Oregon State University to review evidence for climate changes in our region and to evaluate the likely impacts of further changes. They shared their findings through a "Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest."[55] That document, signed by 50 Ph.D. scientists, "agree that climate change is underway and that it is having global effects as well as impacts in the Pacific Northwest region." The document summarizes climate change impacts that have been documented over the last few decades:

- The Pacific Northwest is warming.
- Average annual precipitation has increased.
- Land on the central and northern Oregon coast is being submerged by rising sea level.
- Snow pack has declined.

The report also makes a number of predictions about likely changes over the next 10 to 50 years:

- The Pacific Northwest will continue to warm, perhaps by as much as 3° to 6° F over the next 40 years;
- There will be more summer drought;
- Forests will be more vulnerable to insects, disease and fire;
- Snow pack will continue to diminish;
- Water resource conflicts will likely increase;
- Precipitation changes are too uncertain to call;
- Sea level will continue to rise;
- Peak stream flows will occur earlier in the season;
- Ocean circulation will continue to change, with increased upwelling a possible result. It is uncertain whether these changes will have adverse impacts such as a recurrence of the low-oxygen ("dead zone") events seen in 2002 and 2004; and,
- There will be more frequent and harmful floods and coastal erosion.

[54] Climate Change Science: An Analysis of Some Key Questions; National Research Council, 2001, National Academy Press. See http://www.nap.edu/catalog/10139.html

[55] http://egov.oregon.gov/ENERGY/GBLWRM/docs/Global-AppendixC.pdf

The strategy also recognizes that climate change is affecting the economy of Oregon and that these economic consequences will expand as warming increases. In 2005, more than 50 economists from across the Northwest and most of Oregon's major colleges and universities released a report, "The Economic Consequences of Climate Change in Oregon."[56] The report warns that global warming poses an imminent threat to Oregon's $121 billion economy. The report assesses how temperature increases, rising sea levels, and altered precipitation patterns will directly impact Oregon's agricultural, forestry, tourism, and hydroelectric industries. These four sectors alone account for at least 25 percent of Oregon's economy. The economists note that the impacts of this warming on Oregon resources and economy have no precedent in the state's history.

Acknowledging that efforts to date are preliminary, the economists agreed that available evidence supports the following eight propositions:

1) Rising average temperatures due to global warming will impose economic costs on many Oregonians in the near term, primarily due to lower river flows and restricted supplies of water associated with the loss of mountain snow pack and earlier snowmelt.
2) In the longer term, but within this century, these and other costs are likely to increase as negative effects of rising temperatures and rising sea levels on water supplies, beach loss and coastal infrastructure, agricultural crop production, and forests, fisheries, and other resources become more pronounced.
3) Rising average temperatures also increase the risk of certain catastrophic events that can affect Oregon.
4) Many of the projected changes to Oregon's environment and natural resources (e.g., large reductions in summer water supplies, loss of mountain snow, beach inundation, and changes in regional ecosystems) are likely to have negative effects on Oregonians' jobs, incomes, and quality of life.
5) An insurance approach – spending now to protect against potentially large future costs with an unknown probability generated by climate change – can be a prudent way to protect against both the risks themselves and the future costs of reducing those risks, which are expected to increase the longer action is delayed.
6) "Insurance premiums" against climate change risks include reasonable measures to reduce greenhouse gas emissions, to displace fossil energy use through improved efficiency and local non-carbon polluting energy sources, and to encourage in-state investment in renewable energy technologies and energy efficiency.
7) Such an insurance approach at the state level has the greatest chance of success if undertaken in conjunction with similar efforts by other states and regions.
8) Supporting the development of industries associated with the clean and renewable energy sectors may lay a foundation for job and income growth in Oregon and demonstrate leadership that benefits the state's economy and well-being.

[56] http://ri.uoregon.edu/programs/GWS/climate_change_oregon.html

There are also opportunities for Oregon to develop new businesses and take advantage of opportunities provided by climate change. New technologies for monitoring and predicting environmental change and delivering knowledge services are becoming important economic engines and Oregon can capture a significant portion of this economic opportunity by providing leadership in combating global warming. Developing renewable sources and increasing energy efficiency as well as growing related technology and manufacturing are also key opportunities for economic development.

2. Purposes

The work of the Advisory Group and the Governor's endorsement of its recommendations provide the stepping stones for the Integration Group to move forward. The purposes of the Integration Group are four-fold:

1) Assist me in prioritizing and implementing remaining recommendations in the *Oregon Strategy for Greenhouse Gas Reductions* (2005); receive reports from state agencies and other implementers, and make additional recommendations to achieve the goals of the strategy;
2) Assess the current state of knowledge about the sensitivity, adaptive capacity, and vulnerability of natural as well as human economic and social systems to climate change in Oregon and prepare recommendations about how the state can become more resilient and adapt to unavoidable changes;
3) Stimulate new research programs on mitigation and adaptation strategies in collaboration with the Oregon University System; and,
4) Provide a clearinghouse for sharing information with citizens about climate change impacts and the opportunities in Oregon to address those impacts in an environmentally and economically sustainable manner.

The Integration Group will base its recommendations on the best possible current scientific knowledge, common sense and consideration for the welfare of all Oregonians. The Integration Group will make its first recommendations to Governor by December 30, 2006, with a subsequent more in depth report by December 2007.

A. Parameters for Reviewing the Implementation of the *Oregon Strategy for Greenhouse Gas Reductions*

The Integration Group will track the implementation of the recommendations in the *Oregon Strategy.* It will receive reports on the success of developing policies and implementing actions to achieve the state]s greenhouse gas reduction goals. It will serve as a forum for developing addi tional recommendations to reduce, avoid or sequester greenhouse gas emissions.

B. Parameters for Developing Strategies for Adaptation

Both ecological and human systems are sensitive to climate change. Those at risk include, but are not limited to the following: hydrology and water resources; agriculture and forestry; terrestrial and freshwater ecosystems; coastal zones and marine fisheries; human settlements; winter and

coastal tourism and recreation; energy production; industry; property values; insurance and other financial services; and health.[57] Adaptation is needed now to reduce and manage the risks from climate change.

The Integration Group will look at a range of scenarios and studies of likely climate change and the likely sensitivities, vulnerabilities and impacts on natural and human systems. It will look for the features of a system that keep it resilient, recognizing the inherent complexity of coupled human/natural systems. The Integration Group will look for ways to position the state to take advantage of economic opportunities that can help the state and others reduce greenhouse gas emissions and adjust to climate change.

The Integration Group will look for the linkages between natural and human systems. Ecosystem services are one critical linkage between natural and human systems. Ecosystem services are the benefits provided by ecosystems to people; and, climate change is modifying the delivery of ecosystem services to people. The provision of drinking water, food, flood control, fertile soil, control of pests and diseases, etc., are examples of ecosystem services.

The Integration Group will draw upon the state-of-the-art understanding of climate, ecosystem services, adaptation, resilience, vulnerability, and coupled social/natural systems. It will begin its deliberations with scientific presentations of what is known from scientific research. The Integration Group will start from the "Scientific Consensus Statement on the Likely Impacts of Climate Change in the Pacific Northwest." The group will also use as a starting point the consensus document produced by economists, "The Economic Consequences of Climate Change in Oregon."

The Integration Group recommendations will recognize the inherent uncertainty of any future projections of climate or impacts. Hence, adaptation strategies will be crafted to enhance intrinsic resilience and adaptive flexibility. However, even given the uncertainties of future scenarios, the potential impacts must be estimated in order to balance the costs of doing nothing against the anticipated costs of adaptive strategies.

The Integration Group includes a fair representation of parties with scientific, public, economic, and environmental interests at stake, along with appropriate state agency staff. The Integration Group will review current efforts by agencies, businesses, organizations, and citizens to incorporate adaptation to climate change into their planning and management assumptions. The Integration Group will choose an integrated set of recommendations for specific actions that citizens, businesses, organizations, the State, and local governments should take. The adaptation strategy will complement and, where possible, will enhance the strategy recommended in the *Oregon Strategy for Greenhouse Gas Reductions.*

During 2006, the Integration Group will prepare a strategy that focuses on immediate actions that Oregonians should take to begin adapting to climate change for the most affected sectors. The 2007 report will focus on a more comprehensive assessment of the needs for adaptation and will develop a long-term strategy.

[57] "Summary for Policymakers; Climate Change 2001: Impacts, Adaptation, and Vulnerability; A Report of Working Group II of the Intergovernmental Panel on Climate Change."

C. Parameters for Stimulating New Research in Mitigation and Adaptation

The Integration Group will work with representatives from the Oregon University System to explore new opportunities for research on the mitigation and adaptation to climate change in Oregon and the Pacific Northwest. This will include coordination with Federal opportunities in both science and technology as part of the US Climate Change Research Initiative.

The Integration Group and OUS will develop a set of integrated science and technology initiatives by the end of 2007.

D. Parameters for Serving as a Clearinghouse for Information

The Integration Group will serve as a clearinghouse for information about measures Oregonians can take to reduce their greenhouse gas emissions and to adapt to change. It will provide a forum for all those working on climate change to inform Oregonians of their efforts and successes. It will serve as a locus for learning about efforts at local, state, national and international levels. It will also serve as a source of information for others about what Oregon is doing.

3. Integration Group Structure

Integration Group Co-Chairs

The Governor has named Dr. Mark Abbott and Mr. Ned Dempsey as Co-Chairs of the Integration Group. In this role they will serve as the spokespersons for the Integration Group and will work with the Department of Energy staff and consultants to organize the meetings and direct the process.

Integration Group Membership and Responsibilities

The Governor approved the initial list of Integration Group members. They represent policy decision-makers in key sectors that will be affected by changes to natural and human systems through global warming. Future members may be added by the co-chairs in consultation with the Governor's Office.

It is important to have consistent and regular participation throughout the process. However, if a member cannot make a particular meeting, he or she is encouraged to send an alternate who has been kept informed of the issues and can represent the interests represented by that member.

3.1 Meeting Schedule

The Co-Chairs will develop a meeting schedule in consultation with members.

3.2 Members' Responsibilities

1. Attend meetings, and if there is an unavoidable absence, have an alternate attend and keep the member informed.
2. Represent the interests of their sector as well as possible, but members do not make any commitment for their organizations unless they specifically state that intention.
3. Review materials distributed between sessions and respond in a timely manner to any requests for comment or information.

4. Work together to understand the issues involved and the needs and concerns of other members and to search for consensus.
5. Raise issues, concerns and questions in a timely manner during discussions and/or during e-mail exchanges.
6. Regard silence on an issue as assent. If a member is undecided and thus not speaking on an issue, he/she should make that known to the Integration Group.
7. Consider the public input received on the draft proposals.
8. Assist in preparing reports to the Governor by December 2006 and December 2007.
9. Support implementation of the portions of the recommended proposal if it achieves consensus.
10. Members will speak to the press only about their own views and will not attempt to represent or characterize the views of other members.

Integration Group Elements

1. **Integration Group.** The Integration Group will be composed of stakeholders from the agricultural, forestry, fishing, water supply, electric and gas utilities, various industries, state and local governments, and from environmental, climate change, and other interested parties or organizations.
2. **Staff Working Group.** The Staff Working Group will be a sub-group for coordination of agency policy perspectives, principally through their designated representatives. The departments of Energy, Forestry, Land Conservation and Development, Geology and Mineral Industries, Agriculture, Economic Development, Parks, State Lands, Fish and Wildlife, Environmental Quality, the Public Utility Commission, Department of Transportation, State Economist, and Office of Emergency Management will be invited to participate. Collectively, participating state agencies representatives will make up the Staff Working Group. The Department of Energy has the responsibility for providing the lead on staffing and support for the Integration Group.
3. **Subcommittees.** The Co-Chairs will appoint subcommittees on adaptation, mitigation, and public education to assist the Integration Group. The Co-Chairs will draw on a wide range of expertise and interests for the subcommittees. Participation on the subcommittees will not be limited to members of the Integration Group.
4. **Task and Subcommittee Leadership.** Leadership for specific tasks will be assumed by interested stakeholders, who will work closely with and other stakeholders and agency representatives who have committed to assist with the task.
5. **Observers.** Other states and Canadian provinces may take part in meetings of the Integration Group and Staff Working Group and subcommittees as observers.

Integration Group Decision-making

The Integration Group will make decisions as much as possible by consensus of all members. Consensus for this purpose means that all members will agree to support the elements of the proposal and its implementation. It does not mean that they agree in each particular element that this is the very best design.

The reports of the Integration Group will review Oregon's accomplishments and challenges in achieving the recommendations of the 2004 Advisory Group and will recommend adaptation strategies for the state to the Governor. In the adaptation strategy, it will identify areas where there is uncertainty or where there is not consensus, but where there is significant support for certain elements of the proposal. It will explain the uncertainty or the concerns that prevent consensus on particular recommendations. The first report on adaptation strategies will focus on the major areas where the state is most vulnerable. Subsequent reports will go into greater depth and breadth. The reports will reflect the variety of opinions of the Integration Group and capture the levels of consensus.

Other decisions of the Integration Group, such as direction to the sub-committees, meeting planning and other organizational and logistical matters, will be made by a general sense of the Integration Group, with the decision delegated to the Co-Chairs.