CLIMATE PROTECTION IN EUGENE, SPRINGFIELD, AND LANE COUNTY

An Assessment of Potential Consequences, Emission Trends, and Strategy Options

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The UO graduate student team included Ethan Davis, Shaun Bollig, Renuka Vesepalli, Swati Sanghavi, Greta Onsgaard, Bart Melton and Nicole Luke. Bob Doppelt instructed the class. His teaching assistant was Shanda LeVan.

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EXECUTIVE SUMMARY

This document is the outcome of an applied research project conducted by a graduate research seminar in global warming and abrupt climate change at the University of Oregon. The report begins by explaining global warming and abrupt climate change and the elements of local climate protection action plans. It then outlines the potential ecological and socio-economic consequences of climate change for the Northwest and Lane County, Oregon. The quantity and types of greenhouse gas emissions produced by the internal operations of the City of Eugene are then analyzed. The report closes with preliminary recommendations for ways the City of Eugene could enhance its greenhouse gas emission reduction efforts and provides examples of how other communities as well as private companies are approaching this task and the benefits they are finding from these efforts.

A broad consensus exists within the scientific community in the international, national, and regional levels that climate change is occurring, is far more serious and happening at a much faster rate than previously thought, and is in large part the result of or at least exacerbated by society's production of greenhouse gasses. The speed by which warming appears to be occurring has led some scientists to fear that a threshold may be crossed which leads to dramatic changes in climatic conditions—thus the term 'abrupt climate change' is now being used by an increasing number of scientists. The scientific consensus also suggests that climate change will have significant economic, social, and environmental consequences here and abroad.

The Earth has a built-in "greenhouse" processes that keeps it habitable. Greenhouse gases produced by natural processes trap heat in the Earth's atmosphere and act as a blanket warming for the planet. However, scientists have documented that human activities have increased the levels of greenhouse gases in the atmosphere beyond historic levels, thus exacerbating the Earth's greenhouse effect. Although local temperatures fluctuate naturally, over the past 50 years the average global temperature has increased at the fastest rate in recorded history. The trend is accelerating: the three hottest years on record have all occurred since 1998.

As outlined in a scientific consensus report produced in the Fall of 2004 by the Institute for Natural Resources at Oregon State University, which was signed by 49 Northwest scientists, a broad consensus exists among regional scientists that global warming and abrupt climate change are underway and have effected the Pacific Northwest in recent decades in four broad areas: changes in temperature, precipitation, sea level rise, and snowpack. The scientific consensus document also states that in the next 10 to 50 years, marine ecosystems and terrestrial ecosystems will likely be impacted. These issues, and some of their potential socio-economic consequences, are described in Part II of this report.

The potential ecological and socioeconomic consequences of global warming and abrupt climate change have alerted many state and local governments to the need to develop climate protection action plans. These plans generally include two components: strategies to reduce locally generated greenhouse gas emissions (mitigation plans) to avoid making climate change worse, and strategies to adapt to the ecological and socio-economic consequences of climate change that are now unavoidable.

Abrupt climate change threatens significant alterations to local ecosystems, economies, and social wellbeing. However, public and private organizations that have adopted climate protection plans have found that currently available, cost effective technologies and practices exist that cut the pollution causing global warming while at the same time reducing costs for energy, water, and raw materials, increasing efficiency and productivity, and generating whole new industries and jobs in fields such as energy efficiency, renewable energy and green building. Thus, climate protection plans can help local governments meet existing goals and improve the livability of their communities. These issues are discussed in Part IV of this report.

A first step in the development of a climate protection plan is to understand the current and historic local generation levels of greenhouse gas emissions. This information provides a baseline from which mitigation plans can be developed. Using data provided by the City of Eugene, we analyzed emissions generated from internal government operations for the years 1994–2004. In the past decade, The City of Eugene's internally generated greenhouse gas emissions decreased by 7.5%, from 21,993 metric tons CO2 equivalent in 1994 to 20,351 in 2004. We also determine the sources that contribute to total CO2e: buildings, wastewater treatment, lighting, fleets, and municipal solid waste. In 2004, wastewater treatment contributed the highest percentage of emissions at 44.7%, with buildings accounting for 33.8% of emissions.

Greenhouse gas emissions produced by five other local governments are provided in Part III as a reference and to give an idea of what other city's emissions are. A direct comparison was not made between Eugene and other local governments, because each of the six local governments used slightly different methodologies in assessing total CO2 emissions and there are differences in size of city population, size of city government and jurisdiction, and differences in climate. However, the emissions data is useful in seeing how Eugene's emissions might stack up against others. It appears that total emissions nearly correlate with the size of the population that each local government serves. As population increases, the emissions increase at a similar rate.

Greenhouse Gas Reduction Recommendations and Options

Since 1992, the City of Eugene reported numerous internal actions that have reduced GHG emissions, including energy efficiency and energy use reduction programs, CO2 sequestration programs, and solid waste reduction and recycling programs. Subsequently, greenhouse gas emissions have been reduced or averted. The largest source of emissions reductions occurred when Eugene began to recover methane at the wastewater treatment plant in 1992.

As mentioned, wastewater accounts for 44.7% of the City's internal CO2e emissions, buildings account for almost 34%, while fleets, solid waste, and park lighting produce the remaining 21%. Therefore, the greatest leverage for reductions in total CO2 emissions may be found in additional measures being applied to the wastewater treatment plant and buildings.

Specific recommendations for greenhouse gas reductions for the wastewater treatment plant include shifts to renewable energy and increased public education on water use efficiency aimed at decreasing total wastewater generated, and reducing the amount of organics in the wastewater stream. We also recommend more extensive use of green building practices for new construction and establishing efficiency standards well beyond current code for building upgrades, requiring Energy Star ratings for all 'white goods' (appliances), and where not already occurring, purchasing green power from EWEB or installing renewable energy sources (solar) on buildings. Other recommendations and examples of how other communities are approaching these tasks are offered in Part IV of this report.

PART I: INTRODUCTION AND BACKGROUND ON GLOBAL WARMING AND ABRUPT CLIMATE CHANGE

Introduction

This document is a product of an applied graduate research seminar in global warming and abrupt climate change. Students were provided with the opportunity to learn about and develop an assessment of the causes, potential consequences, and possible local solutions to abrupt climate change.

The class began with an investigation into the research produced by the International Panel on Climate Change (IPCC), the National Center for Atmospheric Research in Boulder CO, and the University of Washington Climate Impacts Group describing global warming and abrupt climate change. This research is summarized in Part I of this report.

The class then investigated a scientific consensus report on climate change in the Pacific Northwest produced by Oregon State University as well as research by leading scientists, economists, and other researchers on the potential economic and social consequences of global warming and abrupt climate change. This led to an analysis of the potential impacts of climate change on the Northwest and Lane County. This research is described in Part II of this document: *Potential Ecological and Socioeconomic Consequences of Climate Change.*

Using data provided by the City of Eugene, the class then quantified greenhouse gas emissions generated by the city's municipal operations over the last ten years. The methodology and findings of this work are found in Part III: *Quantification of Baseline Greenhouse Gas Emissions and Trends.*

Finally, students investigated the City of Eugene's current and past municipal greenhouse gas reduction measures as well as climate protection strategies employed by other local governments. These findings are described in Part IV: *Greenhouse Gas Reduction Strategy Options*. Part IV also provides an initial set of recommendations for how the City of Eugene can advance its climate protection efforts. The appendix provides additional background information as well as a document titled "Frequently Asked Questions About Global Warming and Abrupt Climate Change" intended for use by local officials.

Climate Protection Action Plans

There are two components of a climate protection action plan. The first is a *mitigation* strategy that describes how a community will reduce overall greenhouse gas emissions (GHG). Mitigation strategies are needed at the company/organization/household, local, state, federal, and international levels. The second component is an *adaptation* strategy aimed at proactively preparing the community to adjust to the consequences of climate change that are now inevitable. This project focused primarily on the first component—mitigation strategies. Due to the time available and the fact that most communities have focused on mitigation strategies and few adaptation strategies are currently available to use as models, the UO students did not investigate this issue. However, it may behoove local governments in Lane County to begin development of adaptation plans in the immediate future.

Successful climate protection plans include mitigation and adaptation components. The development of plans generally involves three phases. Phase I assesses the potential consequences of climate change for the local community. Phase II involves setting a baseline and projecting future greenhouse gas emission trends for the local community. Phase III identifies local greenhouse gas mitigation and adaptation strategies. Section II of this report provides a starting point for the completion of Phase I of a climate protection plan for Lane County. Section III of this report provides information to help the City of Eugene complete Phase II of a climate protection plan. Section IV provides a starting point for completing Phase III of a climate protection plan for the City of Eugene.

The steps involved with completing the three phases include:

Phase I: Identify Potential Consequences of Global Warming on the Local Community

1. Identify available environmental, social, and economic data on the potential consequences of climate change on the region, on specific sectors (e.g. forestry, water resources, energy, agriculture, public health), and the local communities.
2. Integrate available data and identify information gaps related to consequences for the local community and region.
3. Develop an assessment of potential consequences for the local community by sector and as an aggregate (looking at interrelationships) using best available data.
4. Identify important topics related to the consequences of climate change on local community for future research.

Phase II: Develop Baseline and Trends of GHG Emissions

1. Develop an historical inventory of GHG emissions by the City of Eugene’s municipal operations (by multiplying energy consumption estimates for sectors such as buildings, transportation, waste management and others by the appropriate emissions coefficients).
2. Develop an historical inventory of GHG emissions for the communities of Eugene/Springfield and Lane County (by multiplying energy consumption estimates for sectors such as commercial and residential buildings, transportation, waste management and others by the appropriate emissions coefficients). *This assessment is yet to be completed.*
3. Develop a projected “Business-As-Usual” emissions trend out into the future based on historical emissions data.
4. Disaggregating the overall inventory into sector-specific emissions to determine which sectors generate the most GHG. This helps identify priority areas.

Phase III: Develop GHG Mitigation and Adaptation Strategies

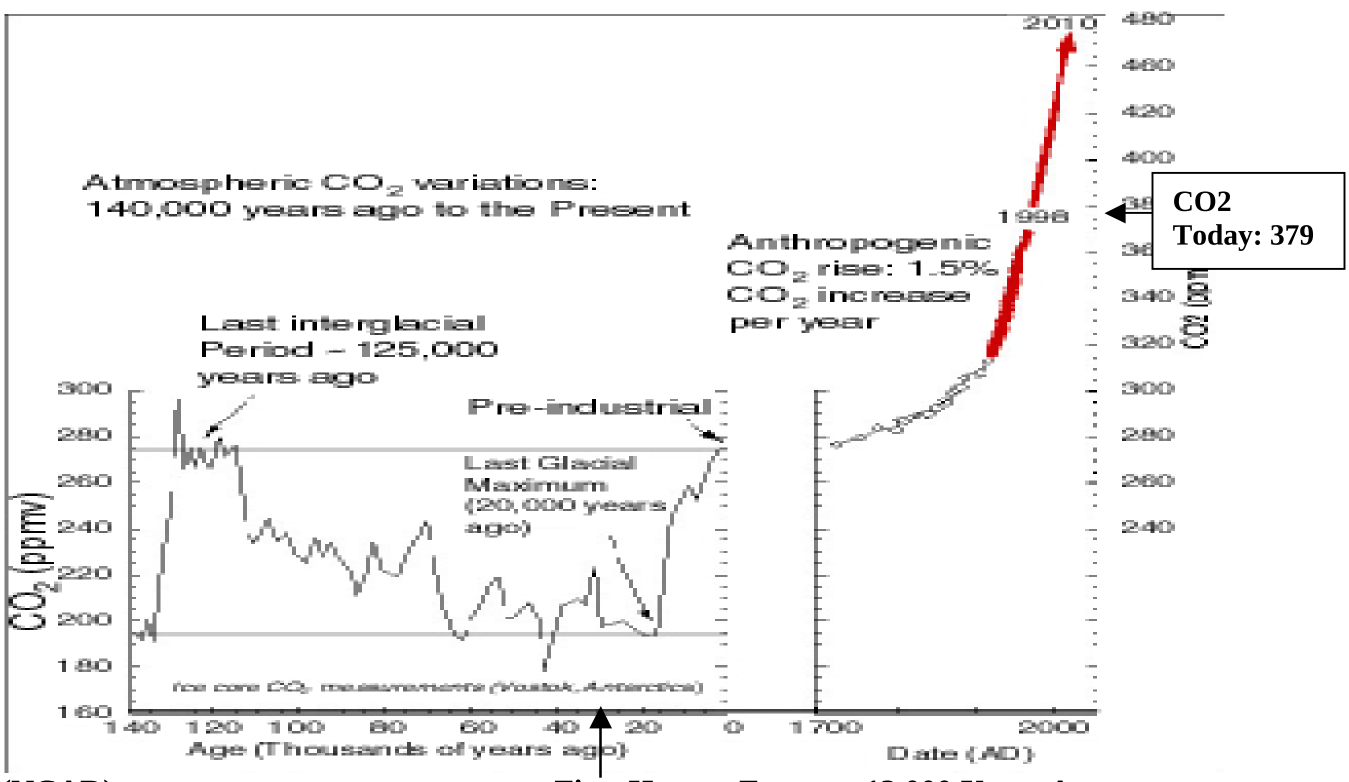
1. Analyze current municipal sector-specific emissions mitigation measures to identify cost-effective strategies for emission reductions.
2. Analyze existing emergency preparedness, natural hazard management, social service, economic development, infrastructure maintenance, power, water, sewer and stormwater utility plans etc. to identify where upgrades or new plans are needed to prepare the community for the potential impacts of global warming and abrupt climate change.
3. Research mitigation and adaptation strategies developed by other cities.
4. Develop mitigation and adaptation plans.

Background on Global Warming and Abrupt Climate Change

A broad consensus exists within the scientific community in the international, national, and regional levels that global warming and abrupt climate change are occurring and are far more serious and occurring at a much faster rate than previously thought (IPCC 2001; NCAR 2005; UW CIG 2005, OSU INR). This scientific consensus suggests that global warming and abrupt climate change will have significant economic, social, and environmental consequences.

A large majority of scientists believe the data clearly shows that human activities are contributing to changes in the composition and function of Earth's atmosphere. Increasing levels of greenhouse gases in the atmosphere, such as carbon dioxide (CO_2), have been well documented. The scientific consensus is that the buildup of greenhouse gases is largely the result of human activities. For example, 86% of U.S. energy use is derived from fossil fuels, which emits CO2 into the atmosphere. Figure 1 shows the classic “hockey stick” graph describing the rise in human-produced greenhouse gasses over time.

Figure 1: Growth of Greenhouse Gas



(NCAR) **First Human Farmers 12,000 Years Ago**

According to the Oregon Department of Energy, greenhouse gas emissions are increasing in Oregon. Between 1990 and 2000 greenhouse gasses increased by 16%, not including methane. Without substantial changes emissions are projected to continue to increase. The Oregon data mirrors national trends. Figure 2 describes the Oregon trends.

Figure 2: Greenhouse Gas Emissions Trends and Forecasts in Oregon

	1990	1995	2000	2015	2025
Gross CO_2	49.2	52.6	57.9	67.1	73.3
Net CO_2	48.4	51.9	57	66.1	72.1
CO_2 From Fossil Fuel Combustion	48.5	51.9	57.0	65.9	71.8
Industrial Processes	0.3	0.3	0.6	0.9	1.1
Waste	0.3	0.4	0.3	0.3	0.4
Landfill Carbon Storage	(0.8)	(0.8)	(0.8)	(1.0)	(1.2)

Source: Oregon Department of Energy

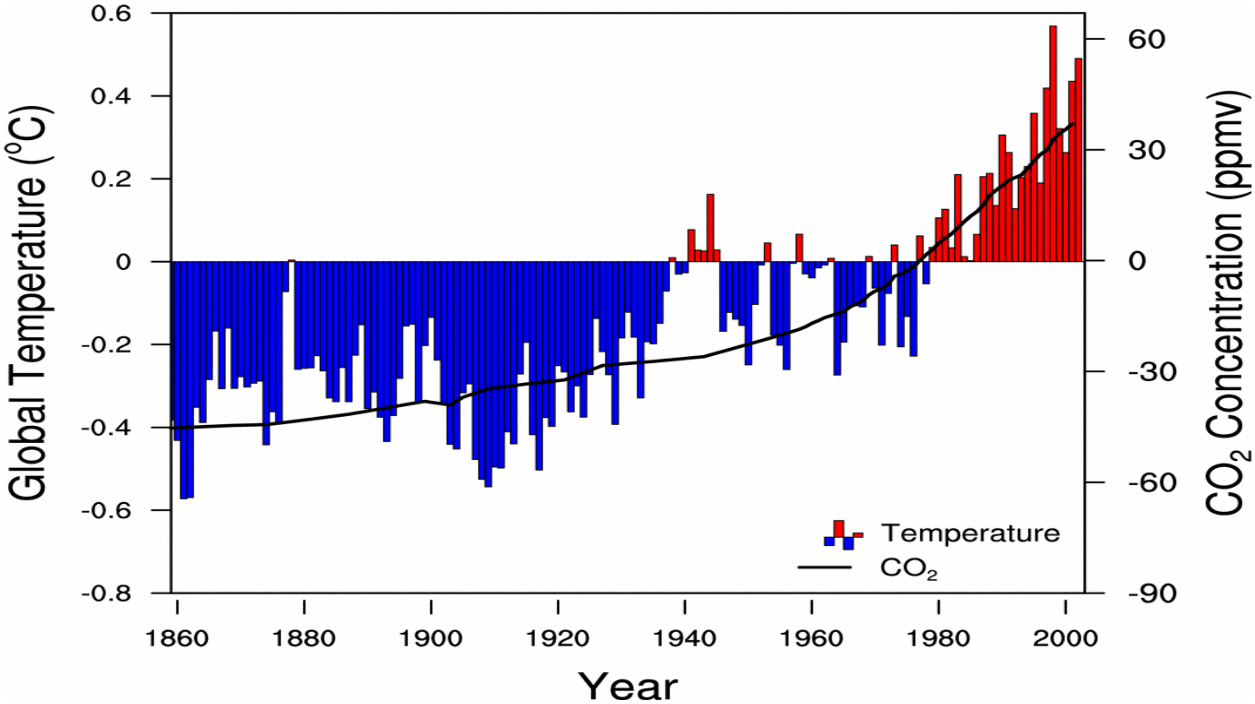
The earth has a built-in "greenhouse" processes. Greenhouse gases produced by natural processes trap heat in the Earth's atmosphere and act as a blanket warming the planet. By increasing the levels of greenhouse gases in the atmosphere, human activities are exacerbating the Earth's natural greenhouse effect. Although local temperatures fluctuate naturally, over the past 50 years the average global temperature has increased at the fastest rate in recorded history. The trend is accelerating: the three hottest years on record have all occurred since 1998 (Hansen 2005). According to NASA, 2004 was the fourth warmest year recorded since the 1800's (Hansen 2005). The highest global average was measured in 1998, while 2002 and 2003 were the second and their warmest years. Although there have been previous periods of warming about 1,000 years ago, no peaks in the past 2,000 years matched recent warming patterns.

Greenhouse gases emitted by human activities accumulate relatively rapidly but dissipate very slowly, causing them to remain in the atmosphere for periods ranging from decades to centuries. Researchers from the National Center for Atmospheric Research in Colorado recently found that because greenhouse gasses dissipate slowly, even if carbon dioxide emissions could be immediately leveled or decreased, oceans will keep rising and global warming will continue for more than a century (NCAR, March 2005).

A growing number of scientists now believe that, although historically major changes in climate systems evolved over hundreds and thousands of years, the possibility now exists that the buildup of greenhouse gases could push the global climate system over a threshold, triggering an abrupt change to a new climate equilibrium. Consequently, the term 'abrupt climate change' is now being used to describe the speed by which the changes appear to be occurring.

Rising global temperatures corresponds strongly with the growth greenhouse gas emissions. Figure 3, developed by NCAR, describes the growth in temperatures and emissions.

Figure 3: Growth in Worldwide Temperatures and GHG Emissions



At the 2005 annual meeting of the American Association for the Advancement of Science, Tim Barnett of Scripps Institution of Oceanography reported current research findings that provide comprehensive evidence of human induced warming of the world's oceans (Barnett 2005). Using climate models, he showed that ocean temperatures increased as carbon dioxide emissions increased. The researcher said that the implications of this are vast and that even if changes in emissions are made immediately, water shortages, melting glaciers, and other crises will occur in the next twenty years throughout parts of the world. The study found that heat and energy levels as deep as nearly a half-mile in some oceans have risen dramatically over the past 40 years, in direct conjunction with rising levels of carbon dioxide and other greenhouse gases. Using new computer models and field tests, scientists at the Scripps Institution of Oceanography in San Diego, CA say they have been able to "screen out the effects of naturally occurring phenomena such as historic weather patterns and solar and volcanic activity, which some skeptics have said are more to blame than greenhouse gas emissions for global warming."

The conclusion that climate change is occurring was reinforced locally in the Fall of 2004 when 49 scientists from throughout the Pacific Northwest signed a consensus document produced by Oregon State University Institute for Natural Resources entitled "Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest." This document describes the following impacts of climate change witnessed in recent decades (OSU INR 2004):

- Temperature: A warming trend of about 1°F has been recorded since the late 19th century. Warming has occurred in both the northern and southern hemispheres, and over the oceans. Confirmation of 20th-century global warming is further substantiated by melting glaciers, decreased snow cover in the northern hemisphere and even warming below ground.
- Precipitation: Since the beginning of the 20th century, average annual precipitation has increased across the Pacific Northwest by 10% with increases of 30-40% in eastern Washington and northern Idaho.
- Sea Level: Land on the central and northern Oregon coast (from Florence to Astoria) is being submerged by rising sea level at an average rate of 0.06 to 0.08 inches annually, as inferred from data for the period 1930-1995.
- Snowpack: Between 1950 and 2000, the April 1 snowpack declined. In the Cascades, the cumulative downward trend in snow-water equivalent is approximately 50 percent for the period 1950-1995. Timing of the peak snowpack has moved earlier in the year, increasing March streamflows and reducing June streamflows. Snowpack at low-to-mid elevations is the most sensitive to warming temperatures.

The bottom-line of this information is that the climate is rapidly changing, the changes are affecting us today and are not something that will occur in the distant future, and that more dramatic variability in climate and resulting ecological, social and economic consequences can be expected. These and other issues will be discussed in more depth in Part II of this report.

The Role of Local Government

While action to address global warming and abrupt climate change is needed at the international and national levels, experience from around the world suggests that the ‘rubber hits the road" at the local and state levels. The mix of energy types, the efficiency by which energy is used in buildings and public buildings and infrastructure, the number of vehicle miles traveled and consequent quantity of fossil fuel used, and many other greenhouse gas-related issues are largely determined by and are best addressed at the local and state levels. Further, the consequences of climate change will primarily fall on local communities, such as intense storms, flooding, droughts, and wildfires. These impacts may affect existing business and job opportunities and pose problems that existing legal and regulatory systems are not equipped to address, insurance policies may not cover, and public infrastructure, emergency response, social service, and public health systems may not be able to manage. For example, more intense winter floods may damage stormwater collection systems. More intense summer droughts and wildfires and the growth of airborne diseases such as West Nile Virus may tax emergency response, health care, and social service systems.

Although global warming and abrupt climate change is likely to generate significant alterations to local ecological processes, economies, and social wellbeing, public and private organizations that have adopted climate protection plans have found they can reduce costs for energy, water, and raw materials, increase efficiency and productivity, and generate whole new industries and thousands of new jobs in fields such as renewable energy and green building. Thus, in many ways climate protection plans can assist local governments to achieve their goals and meet the needs of their community's. These issues are discussed in Part IV of this report.

Although global warming and abrupt climate change will not be prevented by the actions of any single local government or state, the cumulative activities of local and state governments in the U.S. and elsewhere will be critical to resolving the problem.

State and Local Action Toward Climate Protection

A number of state and local governments have taken action to institute climate protection strategies. For example, the governor's of Oregon, Washington, and California joined together in 2004 to form the West Coast Governor's Global Warming Initiative. A similar effort is underway in the Northeast involving New York, Connecticut, Massachusetts and other states. The cities of Portland and Ashland, Oregon, and Seattle, Tacoma, Olympia, and Spokane, Washington have also engaged in climate protection activities. Many of the local governments participate in the Cities for Climate Protection Campaign (CCP), which was established in 1993 by International Council for Local Environmental Initiatives (ICLEI). The CCP is a "performance-oriented" campaign that provides a framework for local governments to develop a strategic plan to reduce greenhouse gases responsible for global climate change and air pollution emissions, with the benefit of improving local air quality and community livability (ICLEI About the CCP).

Five hundred worldwide and over 140 US local governments participate in CCP in a global effort to reduce greenhouse gas emissions and slow global warming. "Cities have found that reducing energy and related [greenhouse gas] emissions yields multiple benefits for communities by enabling them to save money, create jobs, improve the air quality, and generally make the community a better place to live in" (Sonntag-O'Brien 1997, 81). For example, from 1990-1995, Portland, Oregon reduced total emissions per capita by three percent, and carbon dioxide (CO_2) emissions were reduced by more than fifteen percent in city buildings and facilities, resulting in annual savings of $1.2 million and an initial investment of $3.6 million (Sonntag-O'Brien 1997).

Contrarian Views on Global Warming and Abrupt Climate Change

Over the years, some scientists have raised questions about the idea that global warming is occurring or, if it is, can be attributed to anthropogenic (human-caused) sources. Most scientists agree that surface temperatures have increased, but some disagree on the cause of the increase in temperature. According to a New York Times article published on January 29, 2000 entitled "Global Warming: The Contrarian View", some scientists believe that the observed surface warming of about one degree over the last century, with an especially sharp rise in the last quarter century, is mostly or wholly natural, and that there is no significant human influence on global climate. These same scientists also believe that any future warming will be "inconsequential or modest at most, and that its effects will largely be beneficial."

Skeptics of climate change question the accuracy of climate models and other methods used to measure temperature patterns. Some scientists also criticize how and where climate change data is collected. About a decade ago, scientists based their assessment that the earth's temperature was rising on a single set of observations, those at the planet's surface. But some scientists pointed out that surface temperature readings are subject to multiple kinds of distortion, such as heat emitted by the concrete of cities. Consequently, scientists began measuring earth temperatures with satellites. Both sets of data (surface and satellite) found substantial warming over Northern Hemisphere continents at the same time of year, but the satellites didn't show a warming trend for up to about five miles from the surface of the planet. In fact, these measurements showed a cooling trend. Over time the satellite measurements have been improved to filter out the effects of natural, short-term climate fluctuations, such as El Nino, and eliminate other distortions caused by the movement of the satellites. After correcting these problems, the satellites now reveal a general warming trend, but slightly less than the surface record. Because there is a margin of error in using both surface and satellite measuring devices, it's difficult to determine if the difference in temperature is attributable to the error itself or actual differences in temperature data. The computer models used to simulate future impacts of climate change are imperfect and should be used cautiously.

Steven Schneider, a leading climate scientist at Stanford University, feels strongly that the numerous data sets and analyses on climate change are accurate, and that humans are responsible for the changes we have witnessed. In his testimony on July 10, 1997 at Stanford University, Schneider stated, "current estimate of climate sensitivity is not off by a factor of ten, as some 'contrarians' assert." Climate models are able to measure seasonal variation very well, even though the models might be off by five or six degrees. What the models are good at is measuring the amplitude of surface air temperature change. Schneider states that "If we were making a factor of ten error by either overestimating or underestimating the sensitivity of the climate to radiative forcing, it would be difficult for the models to reproduce the different seasonal cycle surface temperature amplitudes over land and oceans as well as they do. Indirect evidence like ice ages, volcanic eruptions and the seasonal cycle simulation skills of models are prime reasons why many of us in the scientific community have for the past twenty years expected that 'demonstrable' anthropogenic climate change was not unlikely by the 21st century…In my opinion it is unlikely that natural variability is the explanation of all climate change, especially that which has been documented in the 20th century."

Schneider's views have been supported by the Intergovernmental Panel on Climate Change (IPCC), which includes hundreds of scientists from all regions of the world (IPCC 2001) and by the consensus statement on climate change produced by the Oregon State University Institute for Natural Resources that was signed by 49 Northwest scientists (OSU INR 2004). These scientific bodies underscore that a strong international consensus exists that global warming and abrupt climate change are occurring and are due to, or at least exacerbated by, human activities.

In sum, there are uncertainties regarding climate change. Some of the uncertainties related to the modeling. However, if one looks at Figures 1 and 3 describing the rise in greenhouse gasses and the correlation with temperature increases, it becomes clear that most of the uncertainty is related to the degree to which warming will affect the environment and society, not if warming is actually occurring. Humans cannot control natural climatic variations. However, we can control our response to the climatic changes that are in motion by taking steps to reduce greenhouse gas emissions. The fact that many of these actions produce win-wins for local governments through cost savings, job creation, and other benefits suggests that climate protection plans can improve the livability of communities and enhance competitive advantage.

Could Warming Be Beneficial?

In the short term, climate change will likely produce winners and losers. Some regions of the country and some economic sectors may benefit by increased warming. However, there is no free lunch—as some regions or sectors benefit others are likely to be harmed. For example, warmer temperatures may, in the short term, benefit some Oregon residents who value a milder climate. At the same time, industries that cannot adapt rapidly to warmer weather or changes in "normal" precipitation patters, may suffer. For example, Northwest farmers that can quickly shift to crops adapted to earlier growing seasons and less precipitation may benefit. However, new entrants into already crowded agricultural markets could lead to oversupply and thus depressed prices.

The long-term effects are even less certain. The climate is changing much faster than scientists first predicted—thus the term abrupt climate change-- and faster than evolution. Historically, climate change has occurred on Earth but most of the changes evolved slowly over hundreds or thousands of years, giving plant and animal species and humans ample time to adapt. By comparison, today's changes are occurring so rapidly that many ecological systems and species may struggle to adapt. This could mean that in the long run every region of the nation and every economic sector will experience significant challenges. Further, no one really knows the end result of climatic changes--all that is certain is that the "normal" stable climatic patterns of the past decades are likely a thing of the past. Greater variance and extremes may become the norm. This means the "benefits" produced in the short run may be dwarfed relatively rapidly by uncertain outcomes as greenhouse gas emissions continue to build up in the atmosphere and warming increases.

No Matter What the Cause, Good Financial Planning and Public Policy Suggests It May Be Prudent To Plan Now for Change

The broad scientific consensus that the Earth is warming suggests that at basic level it does not matter if human or natural processes are the cause. The fact is the climate is changing. This reality suggests that it may be prudent to plan now for the likely changes while a window of opportunity remains open. Reducing greenhouse gas emissions and developing adaptation plans could be thought of as ways to "hedge our bets" against an uncertain future no matter what the causes of the warming may be. Research also shows they can provide significant benefits.

As previously mentioned, a growing stream of research shows that many actions to reduce greenhouse gas emissions will help local governments avoid significant costs in the future and can also generate financial savings, increased efficiency, increased productivity, and generate new industries and jobs today. For example, many energy efficiency upgrades have a 1-3 year payback period that will only get better as energy costs rise. New business and job opportunities are emerging in industries such as renewable energy, green building, and sustainable agriculture. Almost as a side benefit, these businesses help reduce greenhouse gas emissions. Thus, local governments often find that climate protection plans help address many of their existing priorities and programs and can be beneficial to the community. These issues are discussed in more depth in Part IV.

Part II: Potential Local Ecological & Socioeconomic Consequences of Global Warming and Abrupt Climate Change

Introduction

In the fall of 2004, a group of 49 scientists from Oregon and Washington signed a statement produced by the Institute for Natural Resources at Oregon State University (OSU INR) entitled *"Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest*" (OSU INR 2004). The document states very clearly that global warming and abrupt climate change are underway and have effected the Pacific Northwest in recent decades in four broad areas: changes in temperature, precipitation, sea level rise, and snowpack. The document also stated that in the next 10 to 50 years, marine ecosystems and terrestrial ecosystems will likely be impacted.

In this section, the six large-scale ecological consequences outlined in the OSU report are discussed. We have added a section on potential consequences for freshwater ecosystems to the section on terrestrial ecosystems. In addition, research is summarized addressing potential ecological consequences specific to western Oregon and Lane County. Finally, the potential socio-economic consequences of the broad and area specific ecological changes are outlined. Note that the socio-economic research is fairly new and significant data gaps exist. Every effort was made to identify and summarize research relevant to Lane County and western Oregon. Also note that because ecological and economic systems are interdependent, similar consequences appear from different causes. Thus some issues are listed in multiple sections.

<u>Large Scale Ecological Impact 1: Temperature Increase</u>

Global and regional temperatures are projected to continue to rise during the 21st century. According to the most recent projections from the Intergovernmental Panel on Climate Change (IPCC Third Assessment Report 2001), global average temperature is projected to increase 2.7° to 10.4°F (1.5 to 5.8°C) by 2100 compared to 1990 levels (UW Climate Impacts Group).

The OSU scientific consensus statement on climate change states that, "Scientists are very certain that the Pacific Northwest is warming. The SSGCRP Report indicates that the average annual temperature has increased 1-3^{o} F (0.6-1.7^{o} C) over most of the region in the last century. Model simulations suggest that the earlier warming was largely due to natural causes, whereas the most recent warming is best explained by human-caused changes in greenhouse gases. Since 1920, nearly every temperature monitoring station in the Pacific Northwest---both urban and rural—shows a warming trend." (p. 4)

The OSU scientific consensus statement goes on to say, "The USGCRP Pacific Northwest assessments predicts that there will be average warming over the region of approximately 2.7^{o} F (1.5^{o} C) by 2030 and 5.4^{o} F (3^{o} C) by the 2050s. This change translates into a 0.18^{o} to 0.9^{o} F (0.1^{o} -0.5^{o} C) increase per decade. However, rate of increase may be even higher in the eastern portion of the region." (p. 5)

A. Potential Specific Ecological Consequences Of Temperature Increase

The NW scientific consensus statement of climate change lists the following likely impacts in the Pacific Northwest of the projected increase in temperatures:

An increase in elevation of the upper tree line
Longer growing seasons
Increased length of fire season
Earlier breeding by animals and plants
Longer and more intense allergy season
Possible changes in vegetation zones

These issues are discussed in more detail in other sections of this document.

B. Potential Socio-Economic Consequences of Temperature Increases

B1. Increased Fire Risk for Timber Industry and the Urban-Wildland Interface

Temperature increases associated with climate change will likely lead to earlier growing seasons and more extreme drying. These alterations will increase the length of the fire season leading to more frequent and larger forest fires. Intensified fire regimes will affect the forest products industry as well as those living in the urban-wildland interface.

Most of today's forest management practices were developed over a 30-40 year period in which climatic conditions were relatively stable. This stability led managers to believe that even-age management and fire prevention were effective forest management practices. However, studies now show that increasing temperature combined with other climate change related effects such as reduced precipitation and snowpack have created conditions of high variability that are likely to grow over the next century. This means that thinking and practices that may have made sense 5-10 years ago are no longer valid. Whole new approaches are needed that focus on managing forests for increased climatic and ecological variability and change. Leading forest scientists believe that a two-pronged approach is needed to reduce the risk of forest fires: 1) control forest density to protect against wild variations in precipitation and soil moisture as well as insect infestation; and 2) manage for genetic diversity within and among plant species in order to increase forest resilience to ecosystem disturbances such as fires, droughts, and insect infestation (personal communication with Ron Neilson, OSU, March 23, 2005).

B2. Increased Risks to Human Health

B2.1 Heat Stroke and Heat Islands

Increased temperatures may lead to increased incidents of heat stroke in the Northwest. This may lead to more heat related deaths, increase the costs of health care, and cause energy costs to rise due to the need for increased cooling. According to The New England Journal of Medicine, in the 15 largest U.S. cities an average of 1,500 people collapse and die from heat stroke each year, a significant increase over the past decade. The annual death toll from heat stroke in U.S. cities is expected to rise to between 3,000 to 4,000 by 2020.

Heat stroke is a life-threatening illness characterized by an elevated core body temperature that rises above 40°C and central nervous system dysfunction that results in delirium, convulsions, or coma. Despite adequate lowering of the body temperature and aggressive treatment, heat stroke is often fatal, and those who do survive may sustain permanent neurologic damage. Data from the Centers for Disease Control and Prevention show that from 1979 to 1997, 7000 deaths in the United States were attributable to excessive heat. Research suggests the death rate may increase as warming increases.

An EPA report on global warming stated: Heat islands can amplify extreme hot weather events, which can cause heat stroke and lead to physiological disruption, organ damage, and even death – especially in vulnerable populations such as the elderly.

Summer heat islands increase energy demand for air conditioning, raising power plant emissions of harmful pollutants. Higher temperatures also accelerate the chemical reaction that produces ground-level ozone, or smog. This threatens public health, the environment, and for some communities may make it harder to meet federal air quality goals.

Because homes and buildings absorb the sun's energy, heat islands can increase the demand for summertime cooling and raise energy expenditures. For every 1° F (0.6° C) increase in summertime temperature, peak utility loads in medium and large cities increase by an estimated 1.5–2.0 percent.

B2.2 West Nile Virus and Other Infectious Diseases

The increased temperatures resulting from climate change is likely to lead to increased diseases such as West Nile Virus (WNV). On August 13, 2004, Oregon became the last U.S. mainland state to report a case of documented West Nile Virus, found in a crow in Vale, Oregon. It took just over four years for West Nile Virus to spread throughout the U.S. after it was identified for the first time in 1999. Its emergence is attributed to the ability of species that were formerly restricted to warmer climates in the south to move north as warming occurs. Spring droughts and stagnant water in the summer also contribute to the expansion of WNV. Although most cases involve febrile illnesses, neurological symptoms, and death among adults, encephalitis has also been seen in children.

Further temperature increase and drought are anticipated in the Pacific Northwest due to climate change, and the hantavirus and WNV outbreaks have shown that new diseases do emerge from ecologic transitions.(Bunyavanich, Landrigan, McMichael, and Epstein. p. 49).

More that human health may be at risk due to WNV. WNV cost equine industries in Colorado and Nebraska millions in 2002. According to a study evaluating the economic impact of WNV on the equine industries, $2.75 million were spent on preventive measures and the virus cost owners more than $1.25 million. Similar economic consequences could occur in The Northwest and Lane County without proper precautions.

The Environmental Risk Analysis Program at Cornell University is developing a Climate-based warning system. The U.S. government funded research will result in, "the first Web-based, degree-day calculator that warns public health officials when, where and under which conditions infectious mosquitoes can either thrive or die" (Friedlander, Jr., 1). A similar program may need useful in Lane County. In addition, a plan such as the one devised by Lane County may be needed regionwide to identify the practices and programs required to respond to WNV outbreaks. Plan components may include public education, source reduction, surveillance and other mosquito control measures, "from using mosquito-eating fish to the application of larvicides and/or pesticides" (Lane County, OR, 3, Lane County, Oregon's Public Health Response to West Nile Virus).

B2.3 Rise in Mycotoxin-Producing fungi

"Mycotoxins are implicated in the pathogenesis of cancers, ergotism, and birth defects. Alternating drought and flooding may contribute to mycotoxin production. Drought weakens the seed darnels of plants, allowing greater fungal contamination. Flooding causes moist conditions that promote fungal growth" ("Ambulatory Pediatrics, Volume 3, Number 1, January-February 2003," Bunyavanich, Landrigan, McMichael, and Epstein, 47).

B2.4 Increased Incidence of Allergies

Higher temperatures are likely to lead to increased allergies in the Pacific Northwest. "Exposure and sensitization to pollen cause hay fever, allergenic rhinitis, and allergenic asthma. Aeroallergens also trigger and exacerbate asthma, especially among children. Higher atmospheric CO2 concentrations and warmer temperatures are likely to increase ambient pollen levels. Allergies are associated with increased atopic sensitization. Sensitized individuals may need to be confined indoors during allergy seasons to avoid allergic symptoms. Early atopic sensitization can also lead to asthma." (Bunyavanich, Landrigan, McMichael, and Epstein, p. 47).

B3. Impacts on Sensitive Populations

The human health impacts of increased temperatures are likely to have a disproportionate impact on sensitive populations such as the elderly and the poor. These populations are the most susceptible to health impacts from increased temperatures and often have the least amount of resources and capacity to care for themselves once affected. (Comrie and Kolivras)

Large Scale Ecological Impact 2: Precipitation

The ways in which precipitation may change as a result of global warming are much less certain than changes in temperature. More precipitation may result when and if La Nina events occur while less precipitation is likely to result if and when El Nino events occur. Therefore, changes in precipitation are likely to be driven by ocean conditions. The OSU scientific consensus statement on climate change stated that:

> "Changes in precipitation regimes are generally acknowledged to be very uncertain in comparison with the temperature changes described above." (p, 6) … "Recent IPCC global climate model scenarios have suggested the likelihood of modest increases in winter precipitation and decreases in summer precipitation for the Pacific Northwest…Some current research, however, suggests that these scenarios could be wrong for the Pacific Northwest because other factors may influence the outcome. For example, systematic changes in global sea surface temperature patterns, or in other fundamental drivers of global atmospheric circulation, could create systematic changes in storm-track behavior (Water Resources Breakout Group 2004). Based on this hypothesis, the Pacific Northwest could conceivably become drier, despite the intensification of the hydrological cycle on a global level." (P 6)
>
> "The USGCRP Report indicated the Pacific Northwest climate is correlated with ocean-atmosphere events. "Warm years tend to be relatively dry with low streamflow and light snowpack, which lead to summer water shortages, less abundant salmon, and increased probability of forest fires. Conversely, cool years tend to be relatively wet with high streamflow and heavy snowpack. Scientists conclude with high certainty that variations in Pacific Northwest climate show clear correlations with the large-scale ocean-atmosphere patterns associated with the El Nino/Southern Oscillation (ENSO) on scales of a few years (interannual) (Abbott 2004)."

However, Pacific Decadal Oscillations (PDO) and other large-scale ocean atmosphere events are less clearly understood. What is known is that PDO and ENSO events will increase in frequency, intensity and duration. During El Nino events, if there is also a warm PDO phase, both ocean-atmosphere events will positively reinforce each other and lead to extreme weather like drought, forest fires, and dead-zone events. On the other hand, during La Nina cool years and PDO cool phases more extreme events like flooding are likely to occur. In this way, ocean-atmospheric events like PDO and ENSO events will likely determine how severe, and in what way climate change will be expressed in the Pacific Northwest. Also, higher air temperature will increase water temperature. CO_2 is more soluble in cold water. Therefore, the oceans could become a source for further CO_2 inputs (UW Climate Impacts Group). In short,
"The warm phase (El Nino) causes drier conditions in the Pacific Northwest. The cool phase (La Nina) has opposite effects. Recent patterns have suggested a tendency toward more El Nino events and fewer La Nina events" (Wildlife Society 2004 p.2).

Warmer temperatures will likely result in more winter precipitation falling as rain rather than snow, particularly in mid-elevation basins where average winter temperatures are near freezing

(Climate Impacts Group, Water Resources). Oregon will remain as a wintertime-dominant precipitation regime (i.e. most precipitation will occur in the winter), with most precipitation occurring in the mountains (OSU INR p.1). Changes in cool-season (October-March) climate are likely to have the greatest effect on river flow and water resources in Oregon (OSU INR p.5).

A. Potential Specific Ecological Consequences of Changes in Precipitation

A1. Increased Drought and Flooding

Increased frequency and intensity of drought is more likely during warm phases (El Nino) and Pacific Decadal Oscillation (Climate Impacts Group, Water Resources). Flooding is less likely during warm phases (El Nino) and Pacific Decadal Oscillation (Climate Impacts Group, Water Resources) and intense flooding is more likely in mid-winter months in La Nina Events.

Impacts on water resources due to low summer precipitation and earlier peak streamflow will likely include changes in our ability to manage flood damage (OSU INR p.1). This "…could result from increased unpredictability associated with extreme weather events and streamflow forecasting" (OSU INR p.6). Warmer temperatures and increased winter precipitation by the mid-21st century are expected to increase winter flood risks in transient (rain/snow mix) basins (Climate Impacts Group 2004 p.2). "Moderate elevation basins may experience increased winter flooding due to warmer temperatures and possible increases in precipitation. In low elevation rain-dominant basins, climate change may increase winter flooding due to increased precipitation, and reduce late summer streamflow as a result of increased evaporation from warmer summer temperatures" (Connecting Climate and Society p.3). Changes in our ability to mitigate flood damage may warrant reconsideration of current management schemes for storage reservoirs and flood protection (OSU INR p.6).

A2. Insufficient Storage Capacity in Reservoirs

"Most Pacific Northwest watersheds are highly dependent on the accumulation of winter snowpack for meeting summer (April-September) water supply needs. Limited reservoir storage reduces the ability of watersheds to capture winter precipitation and spring runoff for use in the summer and early fall. While building more storage may be an option in some basins, many basins – including the Columbia River Basin – are essentially fully developed" (UW Climate Impacts Group 2004 p.2). "Changes in streamflow volume and timing present a significant challenge for PNW water management given the region's limited reservoir storage capacity (typically only 10-30% of annual flow)" (Connecting Climate and Society p.3).

A3. Changes in Fish Species and Composition and Aquatic Habitat

In the atmospheric warming phase, warm phase Pacific Decadal Oscillation (PDO) is associated with reduced abundance of Coho and Chinook salmon (Climate Impacts Group, Water Resources). During the atmospheric cooling phase, cool phase PDO is linked to above average abundance of Coho and Chinook salmon. In recent years of cool phase PDO salmon returns have rebounded to levels not seen since the 1970s (Climate Impacts Group, Water Resources).

Increased winter flooding and decreased summer and fall streamflows, and elevated warm season stream and estuary temperatures will likely degrade in-stream and estuarine salmon habitat (Climate Impacts Group, Water Resources).

B. Potential Socioeconomic Consequences of Precipitation Changes

B1. Shift In Timing Of Hydropower Supply/Demand

Impacts on water resources due to low summer precipitation and earlier peak streamflow will likely include shifts in hydropower production from summer to winter (OSU INR p.1-2). "Increased winter flows (if precipitation remains the same or increases in winter) that enhance hydropower production in winter months, and reductions in summer streamflow that diminish hydropower production in summer months, may challenge the current approach to hydropower production in the Columbia River" (OSU INR p.6). More water in the winter increases the potential for more hydropower production (Miles 2004).

B2. Decreased Capacity For Hydroelectric Production

The model that predicts a hotter dryer climate, which will result in decreased summer production and increased winter flows, challenge current approaches to hydropower production (OSU INR). This may likely result in frequent, long lasting and large failures of the power system to meet current levels of demand and decrease in the reliability of meeting energy production requirements. This conclusion is reinforced by a draft report on the potential impacts of climate change on Northwest hydropower production produced by staff at the Northwest Power Council (Fazio 2004). Overall, there will be lower river flows. Although there may be less demand for electricity in winter (due to warmer temperatures), this will be offset by increased demand in the summer. The relationship between temperature and electricity demand is clear, according to the Fazio report. Also, runoff volume makes a large difference in total annual generation for the Columbia River system. Energy losses will not be inexpensive, and will result in an estimated regional annual cost of $220 million in 2020 and $560 million by 2040.

B3. Impacts On Electricity Infrastructure

It is anticipated that more frequent, longer lasting and larger failures of the power system will result from the increased power needs in the summers and more intense storms that are predicted (Miles E, Henry B, and Simpson C, 1998).

B4. Decreased Water Quality

Low summer precipitation and earlier peak streamflow will likely lead to decreased water quality due to higher temperatures, increased salinity and pollutant concentration (because water withdrawls decrease water quantity and concentrate pollutants in remaining water), lower dissolved oxygen content with increasing temperature, and increase certain pathogens that thrive at higher temperatures (OSU INR p.2 and 7).

When increased winter flows exist:

1. Heavy rain events during the winter will likely increase runoff and result in more water-borne diseases such as giardia and cryptosporidia (EPA 1998. p. 1)
2. There are likely to be major health risks as a result of flooding. Heavy rainfalls can wash human and animals wastes into water sources, causing more bacterial, parasitic, and viral infections (Physicians for Social Responsibility and Oregon 2002, p.1).

3. Water quality is likely to be adversely affected by higher water temperatures and increased pollutant loads from runoff and overflows of waste facilities (IPCC 2001, a report of working group 2, p. 9).

<u>*When decreased summer flows exist*</u>*:*

1. Low summer flows (in combination with warmer temperatures) is likely to concentrate pollutants and reduce streams' capacity to assimilate wastes (U.S. Environmental Protection Agency, 1998. p.2).

2. The OSU scientific consensus statement on climate change said that increased water temperatures in lakes and rivers, increased salinity and pollutant concentration, lower dissolved oxygen content with increasing temperature that allow certain pathogens to thrive all pose major threats to water quality (p. 6).

B5. Increased Flood Damage

Impacts on water resources due to low summer precipitation and earlier peak streamflow will likely include changes in our ability to manage flood damage (OSU INR p.1)….“which could result from increased unpredictability associated with extreme weather events and streamflow forecasting” (OSU INR p.6). “Moderate elevation basins may experience increased winter flooding due to warmer temperatures and possible increases in precipitation. In low elevation rain-dominant basins, climate change may increase winter flooding due to increased precipitation, and reduce late summer streamflow as a result of increased evaporation from warmer summer temperatures” (Connecting Climate and Society p.3).

Changes in our ability to mitigate flood damage may warrant reconsideration of current management schemes for storage reservoirs and flood protection (OSU INR p.6).

B6. Impacts On Rail, Air, And Highway Transportation

a. *Highway and Rail Transportation*

The frequency, duration and severity of droughts, floods, and fires will likely increase as a result of climate change. These hazards may in turn affect highway and rail infrastructure, operations, and demand. Locally, landslides and flooding may affect highways, city, and county roads as well as rail lines (such as the mail line from California to Washington), decreasing safety, increasing accidents and derailments, and increasing maintenance costs. Researchers have also said that increased mudslides and flooding are likely that will require changes to rail and road infrastructure (e.g. raising roads and railways, making structural changes to bridges, and providing mudslide protection).

b. *Air Transportation*

Mudslides and flooding may put additional temporary and seasonal stress on air travel as people shift to air when roads and railways are closed due to damage or destruction (OSU INR 2004; OEC website). In addition, more frequent and intense winter storms and fog (often related to clear periods resulting from drought) will increase flight delays and the costs of air services. Each cancellation costs between $40,000-$150,000 per flight (U.S. Department of Transportation).

B7. Impacts On Municipal Drinking Water, Industrial Water Supply, And Agriculture

a. *Decreased Water Supply And Increased Summer Demand*
Demands on water systems are growing, but supplies remain fixed and will likely be reduced as warming occurs and summers become dryer. Increased summer water demand is likely to grow as the population continues to grow (OSU INR p. 1 & 6). Studies completed for Portland, Oregon, found that increased demand for water due to climate change will amount to 50% more than that required to meet the needs of a growing population (Climate Impacts Group, Water Resources). This suggests less margin of safety will be available to cope with the unexpected (Miles 2004).

Eugene receives its water supply from the McKenzie River, which has natural storage capacity in the Cascades. However, over time decreased snowpack is likely to impact the capacity of the McKenzie's natural storage system in the Cascades. Springfield obtains its drinking water from wells associated with the McKenzie River hyporheic zone suggesting that it too could suffer in the future if the McKenzie's streamflows are significantly reduced for long time periods. Other communities in Lane County obtain domestic water from a variety of sources, many of which may be affected by long drying periods and reduced snowpack. A complete list of these sources is found in Appendix B.

b. Hydrolic and Management Impacts
"For seven typical dry years, climate change will reduce the amount of water that can be used to meet water demands by an average of 1.5 billion gallons and increase demand during the drawdown period by 2.8 billion gallons, resulting in 4.3 billion gallons of reduced minimum storage. This change will reduce the current safe yield of the years investigated by 21 mgd. These climate impacts exacerbate the need that exists to provide some 9.6 billion gallons of increased demands due to regional growth by 2040." (Palmer and Hahn, 2002, p. 64).

c. Reduced Agricultural Water Supply
Reductions in summer streamflow will adversely affect farmers who rely on irrigation (Climate Impacts Group, Water Resources). The IPCC states that, "Climate change is unlikely to have a big effect on municipal and industrial water demands in general, but may substantially affect irrigation withdrawals, which depend on how increases in evaporation are offset or exaggerated by changes in precipitation. Higher temperatures, hence higher crop evaporative demand, mean that the general tendency would be towards an increase in irrigation demands." (Impacts, Adaptation and Vulnerability, WG2- Summary for Policymakers). See section on consequences for terrestrial and freshwater ecosystems for more information about this issue.

d. Consequences for Lane County's Industrial Water Sources
The principal economic sectors in Lane County are: agriculture, higher education, high technology, forest products, recreation, tourism, and RV manufacturing. Most of these industries require ample, reliable sources of water. Consequently, the potential consequences of climate change on local water systems could have economic implications for these industries. The extent of that impact is unknown, because we don't know for certain what the future will bring.

However, researchers anticipate increased costs to the industries. Small businesses will probably be most affected by an increase in water costs as they have less revenue to make up for the increased costs.

B8. Increased Physiological Stress And Reduced Productivity In Forests

Even if La Nina events occur and total annual precipitation increases during some winters, any climatic changes (such as reduced summer precipitation or increased summer temperature) that result in a net increase in soil and plant moisture deficits are likely to result in increased physiological stress and reduced productivity in Northwest forests (UW CIG p.70). Increased occurrences and intensity of wildfires may also systematically alter the hydrologic response in river basins over time (OSU INR p. 7).

B9. Reduction In Forested Area

"One expected effect of current climate scenarios is for a significant reduction in forest area in both the moist western and arid eastern sides of the Cascade Range. These changes in forest areas are likely to be brought about by wildfires"…"There will be net increases in grasslands, shrublands, and savanna and very significant reductions in "snow zone" communities, such as mountain hemlock forest and alpine and subalpine meadows" (JISAO p.67).

B10. Impaired Forest Regeneration

"Impacts of climate change will be most apparent at forest interfaces and during seedling establishment. Seedlings are especially sensitive to temperature extremes and to drought; establishment success and growth rates may be lower for present-day species seedlings under future climate conditions. Projections for increased frequency of summer drought as a result of climate change could make forest regeneration more difficult during these times" (Climate Impacts Group 2004 p. 2-3).

B11. High Forest Replanting Costs

Projections for increased frequency of summer drought as a result of climate change could make forest regeneration more difficult during these times. If seedling and planting do not succeed, the costs of replanting and of foregone production could be significant" (Climate Impacts Group 2004 p. 2-3).

Large Scale Ecological Impact 3: Sea Level Rise

Scientists believe that global warming is melting ice and glaciers causing warmer seawater to increase ocean levels. The OSU scientific consensus statement on global warming states:

> "During the period 1930-1995, land on the southern Oregon coast between Florence and Coos Bay has generally risen faster than worldwide changes in sea level by about 1mm per year (Abbott 2004). However, the same data, which are based on geodetic leveling and tide-gauge records, indicate that land on the central and northern coast of Oregon (from Florence to Astoria) is being submerged by rising sea level at a rate of 1.5-2 mm (0.06 – 0.08) inches per year.

Current rates of sea-level rise are expected to increase as a result both of thermal expansion of the oceans and of partial melting of mountain glaciers and the Antarctic and Greenland ice caps. The OSU scientific consensus statement on climate change states that, "Sea level is very certain to continue to rise. The impacts of sea-level rise, however, will vary because of differences in tectonic processes throughout the Pacific Northwest." (OSU INR p. 7) Potential consequences of sea level rise include loss of coastal wetlands, barrier islands, and beach sand, and a greater risk of flooding and increased erosion along the Oregon coast.

A. Potential Specific Ecological Consequences of Sea Level Rise

A1. Increased Erosion and Landslides

In some areas where tectonic processes exceed sea-level rise, land will rise faster than increased sea level. Where tectonic processes do not exceed sea-level rise, such as from Florence to Astoria, Oregon, the region's shoreline will move landward. Maximum wave heights also will likely increase. This increase in wave height, in association with sea-level rise, has the potential to increase stream bank and ocean headwall erosion in coastal areas and also reduce or eliminate beach sand in some areas along the Oregon coast. The IPCC found that many coastal areas will experience increased levels of flooding, accelerated erosion and loss of coastal wetlands (IPCC 2001, p. 11).

A2. Alterations to Estuaries

Increases in sea level and decreases in freshwater river flows will affect estuaries through increased salinity and decreasing tidal marsh areas. Coastal estuaries are valued for their biodiversity, including shellfish communities and migrating birds (Report on climate change and Washington p. 2). Estuarial shore lands are generally used for agriculture, forestry, recreation, residential development and other uses.

A3. Loss of Beach Sand

One of the major consequences of rising sea levels in the Pacific Northwest will be loss of recreational beaches and sandy bluffs. Due to subduction of the Pacific Plate, many of the most popular beaches in the Northwest are relatively narrow, and backed by high cliffs. Some of these beaches are likely to be completely inundated within the next century; others will lose substantial acreage. Loss of beach sand may be especially prevalent from just north of Florence to Astoria in Oregon where high cliffs exist close to the ocean. (Whitmore and Goodstein, 2004)

B. Potential Socio-Economic Consequences Sea Level Rise

B1. Impacts to Beaches and Coastal Tourism

As ocean levels rise, many beach communities along the Pacific Coast may see reduced value of ocean front property as well as the dollars generated by tourism. The Climate Impacts Group at the University of Washington found that as ocean levels rise, homes and communities built directly along the shoreline or low-lying inland areas may be inundated or see increased erosion.

Susan Whitmore of Lewis and Clark College (2004) projected lost recreation value to Oregon residents for Oregon coastal beaches to be $39 million for 25% beach loss, $92 million for 50% beach loss, and $132 million for 75% beach loss. As sea levels increase, some beaches will be completely lost which will result in greater visitor density at other usable beaches (Whitmore 2004, p. 1-2).

The Environmental Protection Agency (1998) estimates cumulative costs of sand replenishment along the Oregon Coast to be $60- $920 million resulting from a 20-inch sea level rise by 2100 (EPA 1997, report on climate change in Oregon and Washington, p. 2).

The loss of vacation rental, second home, and beach recreation opportunities may decrease tourism revenue and cause coastal communities to suffer economically (JISAO, impacts of climate variability and change in the PNW. p. 2). With decreased tourism revenue, coastal towns' economies may struggle.

B2. Impacts on Coastal Infrastructure and Related Insurance Industries

Sea level rise may have a number of negative impacts on energy, industry, and transportation infrastructure and consequently on the property insurance industry. Sea level rise, combined with increased frequency and intensity of rain events and subsequent erosion, may adversely affect coastal bridges, culverts, roads, and railroads as well as facilities such as wastewater treatment plants (JISAO, Impacts of climate variability and change in the PNW, p.2). The U.S. Environmental Protection Agency (1997) predicted that as sea levels rise, coastal areas might be affected by shorter life spans for area roads and bridges. New construction projects may need to be undertaken to hold back the increased sea levels. Preventive maintenance and repairs would both involve large capital investment by taxpayers.

UO research identified twelve coastal bridges and four box culverts along the coast in Lane County (Angermeyer). Two more inland bridges in Florence and Mapleton, respectively, go across the Siuslaw River. The Siuslaw River flows into the ocean and thus is affected by tides and is susceptible to sea level increases. Often bridges are not built with the intention of being permanent structures. They are, however, constructed with the intention of withstanding natural hazards. Engineers are currently focused on preparing bridges for potential seismic activity. For example, some coastal bridges are having zinc anodes placed around the iron rebar to discourage the rebar from corroding. However, UO research found that little attention has apparently been given to the potential consequences of sea level rise on coastal bridges in Lane County.

Coastal bridges and culverts in Lane County have endured large rain events. Using the comparison of the 1995 storm, when 5.6 inches of rain fell in Florence from November 27-30, these structures proved to be capable of handling large volumes of water. The biggest threat that more frequent and larger rain events could pose for coastal infrastructure is therefore the possibility of damage as a result of scouring sand and large woody debris.

UO research could not obtain a definitive total number of road and road miles in coastal Lane County. The City of Florence Department of Lane County Public Works manages 205 miles from the coast up to Deadwood (Nelson). The City of Florence also has 2-3 three miles of roads adjacent to the Siuslaw River (Miller). More frequent severe weather and sea level increase would appear to have no adverse effect on these roads in the foreseeable future.

The City of Olympia, Washington, which is built in part on ocean fill, will be threatened by frequent and widespread flooding as the sea level rises, causing trouble for the city's storm water system (JISAO, Impacts of climate variability and change in the PNW p. 3). Similar risks could exist for low-lying coastal communities in Oregon.

B3. Impacts on Water Supply and Quality

The U.S. Environmental Protection Agency (1997) found that sea level rise could lead to saltwater contamination of drinking water in coastal areas for those communities that obtain domestic water from wells close to estuaries or feeder streams (EPA 1997, Report on climate change Oregon and Washington, p.2). Human health is directly threatened by water supplies contaminated by salt water (Physicians for Social Responsibility and Oregon Advisory Board 2002, p. 2).

B4. Population Loss/Shifts out of Coastal Communities

One big unknown related to sea level rise is the extent to which it precipitates population shift. Rising ocean levels and resulting impacts on homes, beaches, and recreational opportunities could result in a population shift out of coastal communities. Population loss in coastal communities may result in increased costs for individuals and government due to the price of relocation, loss of property tax revenue, loss of property income for local property owners, loss of tourism, and impacts on local transportation systems.

At the same time, a countertrend may occur as a result of climate change causing migration to Oregon and the Pacific Northwest of people from poor or increasingly hot and inhospitable regions of the U.S. In-migration may require substantial change in worker and employment conditions, as new workers will need training and education. Support might also be required for displaced workers (Worker Transition and Global Climate Jim Barrett, Economic Policy Institute, December 2001).

Large Scale Ecological Impact 4: Reduced Snowpack

The OSU scientific consensus statement on climate change states that:

> "From 1950 to 2000, warming temperatures across the West have diminished snowpacks. During this period, most monitoring stations in the Pacific Northwest show a decline in April 1 snowpack (or "snow-water equivalent") (Miles 2004). In the Cascades, the cumulative downward trend in snow-water equivalent is approximately 50%. "Model simulations for the period 1950-1995 show that roughly half of the reductions in the Cascades are due to warming trends, and half are due to downward trends in precipitation. Trends for the period 1916-1995 show smaller trends due to warming (a 20% decrease in 82 years) and little effect from precipitation (Water Resources Breakout Group 2004). (p. 4)
>
> "Simulations of snow-water equivalent from 1916-1997 show that the timing of peak snow accumulations and 90% snowmelt have both moved toward earlier calendar dates across the West (Water Resources Breakout Group 2004; Miles 2004). In sensitive areas like the Cascades, for example, the date of peak snowpack has shifted by as much as 40 days earlier in the year. These simulations are supported by studies of observed snowpack, along with observations of stream flow from 1950-2003 which show systematic reductions in April 1 snowpack and June flow, and increases in March flow, over much of the West (Water Resources Breakout Group 2004; Steward et al. in review). (p. 5)
>
> "Snowpack at low-to-mid elevations is the most sensitive to warming temperatures. Watersheds in the Cascades have shown losses of summer water availability due to warming over the last 55 years. The fraction of annual streamflow from May to September in the Cedar River watershed, WA, for example, has declined by 30% in 55 years (Miles 2004). These observable changes in streamflow are not explained by trends in precipitation. (p. 5)
>
> "It is highly certain that the April 1 snowpack will continue to decline in response to increasing global greenhouse-gas emissions. This decline in snowpack will correspond with an earlier peak runoff of snowmelt, and increased streamflows earlier in the year.
>
> "In basins with significant snow accumulation in winter, warmer temperatures systematically reduce peak snow accumulation, producing more runoff in winter, earlier peak flows in spring, and reduced water availability in the summer. Snowpack at higher elevations is generally less sensitive to temperature changes and more sensitive precipitation changes. Thus, at high elevations, snowpack could increase if winter precipitation increases over time. However, even if there is an increase in snowfall at high elevations, the area covered by high elevations is small relative to the area of the entire river basin and consequently the total snowpack in a river basin generally declines if temperatures rise (even if precipitation increases by a modest amount)." (p. 7)

Snowpack in the entire Pacific Northwest (extending into Canada) is expected to decline by 47% by 2090s (Miles 2004). Snowpack in western Oregon and Washington is expected to decline 72% by 2090s (Miles 2004).

A. Potential Specific Ecological Impact of Changes In Snowpack

A1. Changes In Forests Dependent On Snowpack

The OSU scientific consensus statement on climate change states that, "Temperature changes and loss of snowpack are expected to affect forests, particularly those in southwest, central, an eastern Oregon that rely on snowpack for water" (OSU INR p. 7). The UW Climate Impacts Group says that, "In areas of deep snow (the western slope of the Cascades Range, Olympic Mountains, and high elevations in the interior mountain ranges), a reduction in snowpack lengthens the growing season, giving tree seedlings a better chance at establishment" (JISAO p.67). "In dry areas (the eastern slopes of the Cascade Range, the Blue and Wallowa Mountains, and moderate elevations of the Rocky Mountains in Idaho and western Montana), soil moisture is a limiting factor and reductions in snowpack would reduce the amount of moisture available at the beginning of the growing season and increase the length of the late summer drought period; both conditions would make it more difficult for seedlings to establish themselves. The ponderosa pine and mixed conifer forests east of the crest of the Cascade Range are probably more vulnerable to these changes in climate simply because the climate there is so dry. Further increases in evapotranspiration will probably have a bigger impact there than in the wetter forests west of the crest of the Cascade Range" (JISAO p.67).

"In high elevation snowmelt-dominant basins and moderate elevation "transient snow" basins (i.e. basins near the current snow line in winter), warmer winter temperatures will reduce the extent of snow cover and the quantity of water stored as snowpack as more winter precipitation falls in the form of rain rather than snow" (Connecting Climate and Society p.3).

A2. Earlier Peak Snowpack

"The April 1 snowpack will continue to decline corresponding to an earlier peak streamflow" (OSU INR p.2). "Simulations of snow-water equivalent from 1916-1997 show that the timing of peak snow accumulation and 90% snowmelt have both moved toward earlier calendar dates across the West" (OSU INR p.4). The date of peak snowpack in the Cascades has shifted by as much as 40 days earlier in the year (OSU Institute for Natural Resources p.5).

A3. Reduce Summer Flows

"The timing of the peak snowpack has moved earlier in the year, increasing March streamflows and reducing June streamflows" (OSU INR p.1). A shift in the precipitation type from snow to rain, combined with a loss of snowpack, will contribute to higher winter stormflow, reduced spring/summer streamflows, and a shift in the timing of peak spring runoff earlier into the spring (Connecting Climate and Society p.3).

B. Potential Socio-Economic Consequences Changes in Snowpack

B1. Less Water Availability for Municipal Use

Urban water supply systems that rely at least partially on storage of water in mountain snowpack will see diminished inflow to their reservoirs in late spring/early summer (Climate Impacts Group, Water Resources).

B2. Less and More Costly Water for Agriculture

This issue is discussed in the section on terrestrial and freshwater ecosystems.

B3. Increased Frequency and Intensity of Forest Fires

This issue is discussion in the sections on precipitation and terrestrial ecosystems.

Large Scale Ecological Impact 5: Marine Ecosystems

Oceans are thought to be good indicators of global warming because they have higher heat capacity than land and the earth's atmosphere. They also cover more of the earth's surface. Research indicates that global warming is increasing the temperature of the world's oceans. Scientists at the Scripps Institute of Oceanography released research in February 2005 that they claim definitively shows that heat and energy levels as deep as nearly a mile in some oceans have risen dramatically over the past 40 years in direct conjunction with rising levels of carbon dioxide and other greenhouse gasses. Increased temperatures alter the structure and function of marine ecosystems.

The OSU scientific consensus statement on climate change states that:

> "It is very certain that ocean conditions will continue to change in response to ocean-atmospheric processes occurring at the scale of years to decades. These changes in ocean circulation include the intensity and character of upwelling and winds, as well as changes in freshwater input (Water Resources Breakout Group 2004). While the patterns of these variations and their impacts on marine ecosystems (e.g. persistent changes in ecosystem structure, directional changes in productivity, etc) are unknown, paleological records and quantified physical dynamics help to shed light on potential projections. Paleo-records suggest that over long time scales, warm regimes are associated with strong upwelling. It also is know that a warmer continent results in stronger equator-ward winds that fuel upwelling. In combination, these two trends suggest a likely increase in the magnitude and duration of upwelling along the Pacific Northwest coast (Water Resources Breakout Group 2004).
>
> "The emergence of a mass of hypoxic (low oxygen) water (a so-called 'dead zone') appearing off the central coast of Oregon in 2002 and 2004 may signal an unanticipated consequence of climate change mediated through changes in ocean circulation."

Increase in upwelling along the Pacific Northwest coast and the occurrences of low-oxygen ("dead Zone") events are likely to increase as alteration of wind patterns and sea surface temperatures causing colder, nutrient rich water to upwell along the cost. These upwelling waters are nutrient rich, creating algal blooms, which in turn use up dissolved oxygen. Massive fish and invertebrate die-offs may follow. The frequency, intensity, and duration of such events is likely to increase as a result of climate change (Climate Impacts Group; Palmer 2004).

A. Potential Specific Ecological Consequences of Changes in Marine Ecosystems

The OSU scientific consensus statement on climate change states that the consequences of global warming on marine ecosystems in the region indicates potential for:

- Influx of seawater into estuaries and lower reaches of rivers due to sea-level rise,
- An earlier influx of freshwater into estuarine and coastal areas,
- Greater seasonal variation, and
- Increased stress on estuarine and nearshore species that are physiologically adapted to particular patterns in physical characteristics of their habitats (e.g. salinity)." (OSU INR p. 7-8)

A1. Impacts on Salmon

"Most salmon stocks throughout the north Pacific show clear sensitivity to environmental changes associated with the Pacific Decadal Oscillations (PDO)" (JISAO p.55). Changes in ocean food conditions, temperatures, and other factors suggest that salmon will be affected by changes in marine conditions.

A2. Impacts on Coastal Ecosystems and Human Infrastructure

Changes in marine ecosystem conditions are likely to lead to increased levels of flooding, accelerated erosion, loss of wetlands and mangroves, and seawater intrusion into freshwater sources. The extent and severity of storm impacts, including storm-surge floods and shore erosion, is likely to increase. Changes in relative sea level will vary locally due to uplift and subsidence caused by other factors. Impacts on highly diverse and productive coastal ecosystems such as coral reefs, atolls and reef islands, salt marshes and mangrove forests will depend upon the rate of sea-level rise relative to growth rates and sediment supply, space for and obstacles to horizontal migration, changes in the climate-ocean environment such as sea surface temperatures and storminess, and pressures from human activities in coastal zones. These factors influence coastal erosion, landslides, flooding and inundation, estuarine water quality, and invasion of exotic species

B. Potential Socio-Economic Consequences Changes in Marine Ecosystems

See sections on rise in sea level and changes in aquatic ecosystems.

Large Scale Ecological Impact 6: Terrestrial (and Freshwater) Ecosystems

The OSU scientific consensus statement on climate change states that:

> "Changes in temperature and precipitation patterns are likely, but the manner in which these changes will affect the terrestrial ecosystems of the Pacific Northwest is poorly known. Likely impacts include shifts in species composition and timing of the growing season, but the details are unpredictable. For example, temperature changes and loss of snowpack are expected to affect forests, particularly those in southwest, central, and eastern Oregon that rely on snowpack for water. Given current biomass densities, the anticipated direr summers will increase drought stress and vulnerability of forests to insects and diseases, and may ultimately lead to widespread fires that may systematically alter the hydrologic response in river basins over time." (p. 8)
>
> "Summer water flows will drop earlier affecting the need for water especially later in the summer season. Temperature rise combined with unreliable at best water conditions will create a damaging (possibly lethal) situation for fish populations (including salmon) (p. 4-6). … The water quality issues described above could cause changes in the ecosystem and food web that would stress fish, including salmon (p.7).

A. Potential Specific Ecological Impact of Changes in Terrestrial (and Freshwater) Ecosystems

A1. Possible Short Term Increases in Forest Growth

Vegetation change modeling ranges from projections of forest expansion to forest dieback, as a result of uncertainty regarding how projected temperature and precipitation changes will interact to affect drought stress in trees or otherwise modify total annual productivity (Climate Impacts Group, Forests). "Other major uncertainties are whether increased levels of carbon dioxide in the atmosphere would increase primary productivity or help trees withstand reduced soil moisture. The likeliest scenario seems to be that increased forest growth could occur during the next few decades, but that at some point temperature increases would overwhelm the ability of trees to make use of higher winter precipitation and higher carbon dioxide" (Climate Impacts Group, Forests).

The response to temperature and precipitation shifts will favor species with higher water use efficiency, and expand the northern range of southerly species; plants with lower water use efficiency are more likely to experience drought stress and die back (EPA Report 1998). Alteration of forest productivity as a result of higher temperatures, CO2 fertilization, and changes in WUE are still being debated. Direct affects aside, many researchers feel that increases in disturbance such as fire, drought, and insects will offset any increases in productivity (US Global Climate Change Research Program; Bachelet et al 2000). "The net direct effect of the climatic changes is not likely to be favorable to the productivity and stability of existing forests (Climate Impacts Group 2004 p. 67).

A2. Increased Stress from Drought

"Due to current biomass densities, the anticipated drier summers will likely increase drought stress and vulnerability of forests to insects, disease and fire" (OSU INR p.2). "Impacts of climate change will be most apparent at forest interfaces and during seedling establishment. Seedlings are especially sensitive to temperature extremes and to drought; establishment success and growth rates may be lower for present-day species seedlings under future climate conditions. Projections for increased frequency of summer drought as a result of climate change could make forest regeneration more difficult during these times. If seedling and planting do not succeed, the costs of replanting and of foregone production could be significant" (Climate Impacts Group 2004 p. 2-3). Decreased water during growing season will affect sensitive species ability to bud in spring and seed reproduction in summer and fall resulting in decreased NPP, decreased reproduction, and decreased range (Alig 2004). The net result of this drought stress will favor tree species that have higher water use efficiencies (EPA Report 1998).

A3. Longer Fire Season And Increased Susceptibility To Fire

"Changes in fire frequency over the next century in forests west of the Cascades is less clear given that historic fire return intervals are greater than a century, although increased fire frequency in these forests could have significant ecological impacts" (Climate Impacts Group 2004 p.4). A longer fire season and greater likelihood of fires will result in forests east of the Cascades (Climate Impacts Group 2004 p.4). Widespread fires may systematically alter the hydrologic response in river basins over time (OSU INR p. 7).

Changes in the frequency and/or severity of fires are expected to have the largest effect on PNW forests (Climate Impacts Group 2004 p.4). Warmer summers, leading to increased evapotranspirtation, are likely to overwhelm any benefits of increased CO_2 fertilization. One expected effect of current climate scenarios is for a significant reduction in forest area in both the moist western and arid eastern sides of the Cascade Range. These changes in forest areas are likely to be brought about by wildfires" (JISAO p.67). Forest fires will increase in frequency, intensity, and duration, decreasing forest productivity and resulting in more C being lost to the atmosphere further aggravating climate change (Bachelet 2004). There is a possible connection between forest fires, stratospheric chemistry, and ocean events like El Nino and PDO's (Bachelet personal communication February 2005).

Drought and fire tolerant species will replace other less tolerant species over time in the Northwest. These new species in turn will reinforce fire and drought disturbance regimes. (Bachelet et al 2004). Alteration of forest structure following species replacement, fuel accumulation, fuel wetness, and height of new species/undergrowth will alter intensity of fire disturbance, influencing crown or surface burn (Dale 2001). Snags, downed coarse woody debris, and other legacies of climate change resulting in dieback will increase the likelihood and intensity of disturbance (Bachelet et al 2001). Temperature will increase fire season length, drought or decreased water will increase likelihood, increased WUE by trees increases fuel dryness. Fire disturbance will result in seed bank changes, CO_2 loss, aggravating climate change, potential OM and nutrient loss, and decreased moisture due to decreased evapotranspiration and cloud cover, and run-off. This in turn will favor plants with a high WUE and NUE, serotinous cones or other fire adaptations, and reinforce species replacement and disturbance regime (Flannigan et al 2000).

A4. Changes In Ecological Succession

"High-intensity disturbances reset forests to the establishment stage, which is the stage most sensitive to adverse environmental conditions, such as drought and heat."…"Changes in the frequency and intensity of disturbances will affect ecological succession, particularly if summers become both warmer and drier. For example, increased disturbance in Pacific silver fir forest combined with warmer, drier summers that may limit the re-establishment of silver fir, may result in transition to Douglas fir-dominated forests at middle elevations" (JISAO p.64). Likely impacts of fire include shifts in species composition and timing of the growing season, but the details are unpredictable (OSU INR p. 7).

Plant communities will undergo individualistic shifts in their species composition, rather than in their collections of associated species, and/or experience changes in densities (Climate Impacts Group, Forests). Extinction of local species is expected (Climate Impacts Group, Forests). Species with poor dispersal ability may have difficulty in shifting their spatial distributions (Climate Impacts Group, Forests).

A5. Changes In Forest Disturbance

Climate change will alter the frequency, type, size, intensity, timing, seasonality and duration of disturbance. Seven primary types of disturbance affect NW forests: Fire, drought, introduced species, insect outbreak, pathogen outbreak, hurricanes, and windstorms (Dale et al 2000; Dale et al 2001). Species replacement and regeneration will be greatest following disturbance. Introduced species, insects, and pathogens will increase as they out compete native plants for nutrients or water; have a longer breeding period; or are otherwise reproductively favored by climate change. Disturbance will therefore accelerate changes in composition resulting from climate change both directly—species replacement—and indirectly—by favoring more grasses or southerly, more fit species (Dale et al 2000; Dale et al 2001).

Climate change, disturbance, and forest productivity affect and are effected by one another. Many climate change models do not incorporate disturbance into their predictions and as such make erroneous predictions. As forests are stressed through nutrient availability, water availability, temperature, competition, etc resulting from climate impacts, there susceptibility to disease, insects, and introduced species increases. This alone would decrease any potential gains in NPP, growth rates, or potential harvests resulting from serendipitous secondary affects of climate change. More importantly however, fire and drought will increase as disturbance regimes, not only affecting the forest, but also regional climate as well, in such a way so as to aggravate climate change, increase disturbance, and decrease forest health and development. (Dale 2000; Dale 2001; Bachelet 2001 Flanningan et al 2000)

A6. Alteration of Adiabatic Cooling

Changes in forest cover to grassland as well as changes in snowpack and hydrology will affect adiabatic cooling by changing latent and sensible heat loss from the system. A critical outcome of global warming, adiabatic cooling or heat loss is equal to the net heat trapped by atmospheric gases. Latent heat is responsible for cloud formation and precipitation and will have significant local effect. This will further increase water loss from the system, especially notable in an area like central Oregon, where current predictions suggest drier conditions based on temperature changes and reduced snowpack/streamflow. Sensible heat will also increase locally, and this could in turn raise temperature, especially in the more closed Willamette Valley bordered as it is by the Coast and Cascade ranges. (Marland et al 2003; Massera et al 2000)

A7. Changes in Organic Matter and Nutrient Cycles

Increased temperature will result in an increase in microbial activity resulting in greater CO2, N, P, and K fluxes from the system. This will favor trees and plants that have a higher NUE (Shlesinger 1997, Andrews et al 1996). Any potential increase in microbial activity resulting from a temperature increase will be diminished by water availability. Decreased water will result in decreased activity (Bachelet et al 2004). Micobial activity is the key interface between forests and climate, alteration in their function will have significant impact on forest regeneration, productivity, and distribution (Hansen et al 2001).

A8. Invasion Of Trees Into Subalpine Meadows

"At upper treeline, tree ring analyses of mountain hemlock (Tsuga mertensiana) demonstrate tree growth responses to climatic variations. Decade-to-decade variations show a good correlation with the PDO. Also at upper timberline, significant tree invasion of subalpine meadows is associated with light snowpacks and long growing seasons" (JISAO p.63).

A9. Loss of Biological Diversity

"Loss of biological diversity is likely if environmental shifts outpace species migration rates and interact with population dynamics to cause increased rates of local population extinction" (Climate Impacts Group, Forests). Increased temperature and changes in precipitation will alter migration of animals, hibernation, and male-female ratio (in some populations) and as a secondary result, the ability of tree species to migrate northward because of decreased seed dispersal, thereby slowing northward movement of southerly species. (Schlesinger 1997)

A10. Little Projected Change At Middle Elevations

"At middle elevations in the interior Northwest, and in the western hemlock and Pacific silver fir zones west of the Cascade crest, the structure and composition of most mature forest stands have little measurable sensitivity to climate variations. Forest stands have the ability to buffer themselves against variations in climatic conditions" (JISAO p.63).

A11. Impacts on Salmon

"Climate variability plays a large role in driving fluctuations in salmon abundance by influencing their physical environment, the availability of food, the competitors for that food, and the predators that prey on small salmon. The complexity of influences on salmon, both climate and otherwise, combined with the scarcity of factors important to salmon in estuaries and the ocean, make it challenging to identify the links between salmon and climate" (Climate Impacts Group, Salmon). "Salmon are the most vulnerable to climate variations at the migrating smolt stage," but what applied to one salmon run, or even one salmon species, may not apply to all (JISAO p.54). "The most important factors for juvenile coho freshwater survival are (1) the instream temperature during the first summer, combined with the availability of deep pools to mitigate high temperatures; and (2) temperature during the second winter, combined with the availability of beaver ponds and backwater pools to serve as refuges from cold and high stream flow events. Consequently, increases in summer water temperature will affect coho most if they occur in combination with decreases in summer stream flow…" (JISAO p.57).

A12. Degradation of In-stream and Estuarine Salmon Habitat

Where winter temperatures are now cooler than optimal for juvenile salmon and/or incubating eggs, warming may improve stream productivity; however, such conditions are now limited to a very small number of inland, high elevation salmon bearing streams (Climate Impacts Group, Water Resources). On the other hand, increased winter flooding and decreased summer and fall streamflows, and elevated warm season stream and estuary temperatures will clearly degrade in-stream and estuarine salmon habitat (Climate Impacts Group, Water Resources). The likelihood for many positive impacts is low.

B. Potential Socio-Economic Consequences of Changes in Terrestrial (and Freshwater) Ecosystems

B1. Potential Consequences For the Forestry Products Industry

It is impossible to say with certainty how forests will respond to climate change. At best, different scenarios can be offered of likely forest response and economic impact. There are several scenarios for the impact of climate change on forests. These direct ecological impacts will affect not just resource value, extraction, and processing, but indirectly, also exert considerable influence on local and international market dynamics (Irland et al 2001). The combination of these effects will determine the economic impact of climate change on forests in Lane County. Current models stress either ecological or economic dynamics; and a coupled economic-ecological model that would capture the direct and indirect effects is not available. Because of the inherent complexity and uncertainty of forest response and market dynamics, an exact cost cannot be calculated. Instead, socioeconomic scenarios suggest that market response and financial costs will be closely tied to forest response.

The economic impact to Lane County will be directly determined by two potential ecological consequences—the type, frequency, and intensity of species replacement; and alteration of forest productivity (NPP). A 1998 EPA report suggests that Douglas Fir, Lodgepole Pine, and Ponderosa Pine will replace more water dependent Hemlock and Sitka Spruce. Each of these tree types has a different market value today: Douglas Fir $400/thousand board feet; Lodgepole Pine $100; Ponderosa Pine $100; Hemlock $225; Sitka Spruce $225 (Sundance Lumber Company, personal communication February 2005). The proportion of a higher or lower value tree species replacing current stands will determine if species replacement will increase or decrease forest inventory value. The frequency and intensity of future species replacement is not known, and some researchers suggest that there will be no change in composition, only a decrease in tree density (Nielson, personal communication 2005).

Some economic models assume that forests will become more productive as a result of climate change (at least in the short run). Alteration of forest productivity as a result of higher temperatures, CO_2 fertilization, and changes in WUE are still being debated. Direct affects aside, many researchers feel that increases in disturbance such as fire, drought, and insects will offset any increases in productivity in the long run (US Global Climate Change Research Program; Bachelet et al 2000). Decreases in yields will favor producers and negatively affect consumers (Alig et al 2004). Changes in supply vs. demand driven market economics will change pricing structure--if the supply decreases then prices increase. Quality and size also determine timber value. If researchers are correct, and insects and diseases increase following climate change, then quality will be diminished, and subsequently timber value decreased (Dale et al 2001). Lastly, the impact of climate change on forests worldwide and competitors such as Canada, Russia, Indonesia, and other producers, will directly affect supply and pricing for Lane County (Rooney, personal communication). In total, these market forces will impact the forest products industry in Lane County.

Inventory levels may initially decrease as existing stands suffer direct and indirect ecological effects, resulting in increased salvage logging and decreased product value (Irland 2001). Increased disturbances will accelerate species replacement. New species will lead to new disturbance regimes. (Bachelet 2000). Private owners, the predominant source of Oregon timber, may plant more fir trees resulting in further species change. (Alig 2004)

Forests and the wood product industry are dependent on each other and with CO2 flux and climate. This means that forest management practices will not only manage the effects of CO2 and climate change, but also influence CO2 production and sequestration and climate change. (Irland 2001; Bachelet 2004). Because of this interrelation, management will have to mitigate the impact of climate change (defensive strategy); while at the same time account for the impact of forest management on climate (offensive strategy) (Marland 2003, Doppelt 2004). This is realized not only through changes in CO2 flux resulting from market and ecological forces regulating C sink or source dynamics; but also based on land-use changes affecting the adiabatic cooling as land-use patterns change based on market and ecological conditions. (Marland 2003)

Harvest levels will initially decrease as species replacement occurs. This is likely to continue in the future because increased forest fire intensity and frequency; and increased duration and severity of drought following decreased snowpack, and streamflow and new WUE; will result in managers responding with increased stand thinning (Alig 2004; Flannigan 2000; Houghton 1996). Any potential increase in NPP or growth rates of forests following the direct ecological effects from temperature increase, CO2 fertilization, resource substitutability, increased NUE, or increased WUE; will be offset through an increase in the frequency, scale, duration, and type of disturbance to these forests (Bachelet 2000, Bachelet 2004). Changes in the supply will reflect the alteration of species composition; geographic range; health; increased intensity of disease, insect pests, fire or drought; and forest productivity following direct and indirect ecological forces (Alig 2004). Supply changes in turn will affect production capacity, change the market pricing of product, and subsequently alter patterns of consumer consumption (Alig 2004). Harvest age is expected to decrease following decrease in forest health and stress induced senescence in existing stands; and thinning expected to increase in response to greater fire and water stress; both of these result in thinner, less productive stands (Alig 2004).

The net effects of ecological impacts and market response will determine the exact economic consequences in Lane County (assuming no change in policy). What is clear, is that climate change will impact forests, and that these impacts will significantly affect the wood products industry in Lane County. The wood products industry currently employs 6,904 people, or 31% of all manufacturing employment in Lane County, has an annual payroll of $179,667,000, and produces over $ 1,540,448,000 in goods. Reductions in yields, quality, or value in this sector, even if small, would have significant implications for the county.

B2. Structural Adjustments in the Forest Products Industry

In addition to changing the type of trees planted and levels and timing of harvests, forest products firms and private landowners may either shift their capital to regions with economic advantages in timber growth (e.g. move north or to moister areas), or change land-use to maximize profit from forest to agriculture, urban development or other uses depending on market reaction (Irland et al 2001). Land-use changes will result in localized changes in precipitation or temperature following changes to latent and sensible heat (Marland 2003).

Climate change will affect the condition, composition and productivity of forest. These biological changes are likely to set in motion regional changes in supply of wood to sawmills and paper mills, in turn producing effects on market prices. Already stressed markets may lose key competitive advantages, which, in conjunction with supply changes, affect market prices (Irland 2001). Current economic-ecological predicting increases in forest productivity do not take into consideration disturbance, or other ecological forces that result in erroneous predictions of increased forest productivity (Dale 2001). Population and demand, resource conditions, product markets, international trade, and the balance between consumer-producer welfare will ultimately determine market response (Irland 2001). It will be the collective market impact of the balance between consumer savings and producers profits following alteration of forest NPP that will determine whether a region maintains an economic competitive advantage, and if the wood products industry is positively or negatively affected (Irland 2001; Swanson 1996 PNW-GTR-361). Increasing yields may benefit consumers and negatively affect producers. Decreasing yields may negatively affect consumers but benefit producers. These patterns will be determined as the market expresses itself through pricing fluctuations depending on decreased or increased inventories. (EPA 1998, Irland 2001)

It must be noted that the models used to predict changes in forest condition are limited. Productivity will increase or decrease depending on forest area and condition, this in turn will increase or decrease prices, alter consumer-producer patterns, market behavior, and regional competitive advantage. This in turn will ultimately determine how timber growing and wood production respond to climate change (Irland 2001). There are a variety of ecological-economic models that attempt to predict the affect of climate change on the wood products industry. Economic models do not consider disturbance as an influence of forest response to climate change (Dale 2001). Ecologic models in turn do not incorporate market influences, or direct manufacturer adjustment in their prediction of forest change (Bachelet 2000). These models all suggest that climate change will affect timber production and markets; but how and to what degree is a result of forest productivity, forest area, condition, inventories, timber prices, competition, and market welfare. None of the current models take into consideration all of the feedbacks between these variables into their projections. Therefore further research is needed into the socioeconomic affects of climate change on the wood products industry (Irland 2001; Bachelet 2000).

B3. Consequences for Recreation and Tourism

Changes to terrestrial and freshwater ecosystems will likely lead to negative consequences for tourism and recreation in Lane County. U.S. EPA says that conflicts are destined to arise in relation to water use for recreation due to climate change (Environmental Protection Agency, Report on Climate Change in Oregon, September, 1998). Freshwater streamflows will drop earlier in the year causing increased demands on available water especially later in the summer season, thus reducing fishing and boating opportunities. Temperature rise combined with unreliable at best water conditions will create a damaging (possibly lethal) situation for fish populations (including salmon) (OSU INR, p. 5-6). The increased likelihood and magnitude of forest fires will set large forest areas off limits to recreation and tourism and make others, including possibly Eugene-Springfield and other urban areas, less desirable due to smoke incursion. Increased temperatures may also make Lane County less desirable as a tourism destination compared to cooler areas to the north.

Tourism is an integral component of Lane County's economy. The diversity of the county's landscape, from the ocean beaches to the Cascade Mountains and multitude of rivers, streams, campgrounds, and hiking trails within a relatively small geographic region allows tourists to experience a wide array of activities. Visitor spending has a profound impact on the economy. According to Dean Runyan and Associates, visitors to Lane County spent $473 million in 2003, generating 7,700 jobs with earnings of $129 million and $18 million in state and local taxes. A weakened economy in 2003 failed to promote the pattern of tourism growth that Lane County has enjoyed for the last twelve years (Dean Runyan Associates, 2005, p. 3).

According to the Oregon Department of Fish and Wildlife there were 71,677 hunting and fishing licenses sold totaling $1,555,404.00 sold in Lane County 2003. This does not include funds spent in Lane County for hunting and fishing licenses sold out-of-county (E-mail from Harry Upton, February 7, 2005). In 2003, $61 millions was spent at campgrounds, $189 million at hotels, motels and B&B's, $59 million on private homes, $9 million on rental homes, and $148 million on day travel (Lane County Travel Impacts Statement, 2004). East Lane County accounted for $361.7 million of tourism related spending and generated $96.6 million in direct earnings, while employing 5,690 people (Dean Runyan Associates 2005, p. 8). West Lane County created $111 million in spending, with $32.4 million in direct earnings as it employed 1,960 people (Dean Runyan Associates, 2005, p. 9). Florence, the largest city in the coastal region, generates an estimated $140 for per tourist per day (Capen 2005).

B3. Consequences for Agriculture

Agriculture is also an important part of the economy in Lane County. At the state level, $3.7 billion dollars is generated annually by farming and ranching. Agricultural products account for $1.1 billion of total state exports or 12.4 % of all exports, leaving $2.6 billion in internal sales (Oregon Blue Book 2004). These numbers are not available at a county level (Rooney, personal communication; Mecham, personal communication).

Much like forests, the direct effect of climate change on agriculture is still open for debate among researchers. Unlike forests, however, farmers have a much greater degree of plant choice, faster response time (single season vs. 30 year rotations), and access to water and inputs such as fertilizers, pesticides and herbicides. Because of the greater degree of control, it is thought that farmers and agriculture will be able to adapt more quickly to climate change (US Global Climate Change Research Program). While the direct impacts are uncertain, it is likely that climate change will lead to substantial changes in the local agricultural economy. For example, a 1998 EPA report concludes that important Oregon crops like wheat will increase in yield, whereas hay and potato will decrease in yields.

The key determinant of the consequences of climate change for agriculture is drought tolerance (McCarl et al 2001). Each crop may respond differently to changes in climate and atmospheric composition. Most crops are expected to grow better provided enough water is available, and other non-climatic conditions do not change (Climate Impacts Group 2004 p.5). However, decreases in summer rain will increase water stress on plants. Not only will plants be more stressed, but the ability to irrigate will also be reduced because of decreased snowpack and streamflows (IPCC 2000). Plants will need more water, but there will be less water available for irrigation in the summer and fall while evaporative demand during the growing season is likely to increase (Climate Impacts Group 2004 p.5). In addition, as water supply decreases demand from urban areas is likely to intensify competition for available supplies, thus increasing the costs of water. In addition, disease, pests, and weedy plants are all likely to increase due to climate change (IPCC 2000; Pimmentel 1993). This leads some researchers to predict that increased fertilizer, herbicide and pesticide use, as well as increasingly needed but costly irrigation water, will lead to decreased plant growth and agricultural output (US Global Climate Change Research Program).

Lane County is expected to experience negative consequences, but they are likely to be less dramatic than more southerly states like California, where increases in water demand, and decreased supply will tax an already stressed agricultural irrigation system. What is clear is that reductions in yields, even on a small scale, would have a costly impact on local food-production and exports. The sum interaction of temperature change, CO2 increases, decreased soil moisture, increased disease, weeds, and insects are likely to reduce agricultural yields. Some researchers have suggested that agricultural yields will decrease by up to 27% (US Global Climate Change Research Program; Pimmentel 1993).

PART III: QUANTIFICATION OF CITY OF EUGENE INTERNAL OPERATIONS GREENHOUSE GAS EMISSIONS AND TRENDS

Introduction

After the potential consequences of climate change for a local community or region are analyzed, the next step in developing a climate protection plan is to identify sources and quantities of greenhouse gases emitted by a community. Greenhouse gasses produced by internal municipal operations and community-wide emissions should be quantified. This data provides the baseline needed to identify appropriate emissions reduction targets, strategies, and monitoring measures.

Using data provided by the city, we quantified the greenhouse gas emissions generated from the City of Eugene's internal operations for the years 1994 through 2004. The assessment included an inventory of carbon dioxide from the combustion of fossil fuels and methane from landfill waste decay (together represented as CO2 equivalent, or CO2e). It covers buildings, park lighting, fleets (gas, diesel), wastewater treatment (electricity, natural gas), and solid waste (methane). The assessment also offers a projection of emissions for 2006-2020 assuming no further policy or operational changes are made (i.e. a business-as-usual scenario).

The following assessment is for City of Eugene internal municipal operations only. Quantification of emissions for internal operations at the City of Springfield and Lane County government as well as for the communities of Eugene, Springfield, and Lane County (including the UO) are expected to be complete by late summer 2005, assuming data can be obtained.

Methodology

<u>Data Sources</u>

Data on building energy use (electricity, natural gas, steam, fuel oil), park lighting (electricity), fleets (gasoline, diesel), wastewater treatment (electricity, natural gas), and solid waste (methane production) was provided by staff from the City of Eugene. See Appendix C for a chart of all data provided by the City.

Important Notes:

- Use of fuel oil was phased out in 1999.
- Natural gas produces the steam used by the City. Wood as the fuel for producing steam was phased out prior to 1994. It is also important to note that there is considerable line loss in getting the steam from EWEB to the city and this lost steam in not accounted for in this assessment. This could be incorporated in future assessments.
- Prior to 2004, only combined diesel fuel numbers were available, which affects diesel CO2 emissions. In August 2003, the city switched to using 100% B20 biodiesel fuel (20% biodiesel/80% diesel). Therefore, the city's 2003-04 fiscal year numbers include one month of combined diesel numbers.
- A few gaps were found in the gasoline and diesel fuel data. Therefore, to calculate the 2001 fuel consumption, an average of consumption in 2000 and 2002 was used. The years 1996, 1997, and 1998 were estimated using an average of 1995 and 1999 consumption figures.

- Total municipal solid waste data was only available for 2001 and 2004. 2004 data was used for 2002 and 2003. 2001 data was used for 1994 through 2000. Categorical solid waste consumptions were only available for 2002, and were assumed to be consistent from year to year. The other waste category represents a broad diversity of materials, thus it is difficult to accurately allocate how many metric tons of CO2 it generated.

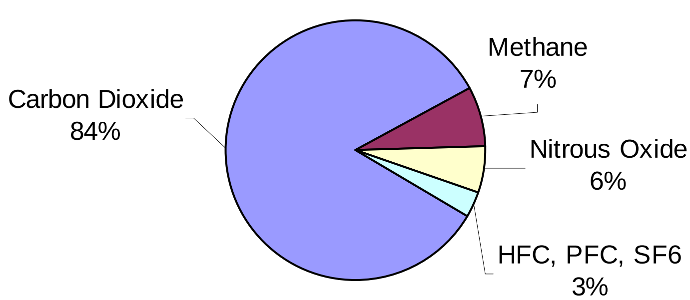
Quantification Model and Emissions Factors

The greenhouse gas emissions assessment was conducted using the model developed by the Cities for Climate Protection and the associated software called CCP Greenhouse Gas Emissions Software (January 2004) developed by Torri Smith Associates and adapted by the City of Fort Collins, Colorado.

Methane, nitrous oxide, and halocarbons are significant greenhouse gases, but scientists believe the pollutants of greatest concern are CO2 and methane. The majority of CO_2 pollution comes from burning fossil fuels, such as coal, gasoline, diesel and natural gas. The majority of methane pollution comes from wastewater treatment facilities and landfills. In Oregon, about 84 percent of greenhouse gas pollution comes from CO_2 emissions (see Figure 4; Oregon Department of Energy). Emissions from methane contribute 7 percent of greenhouse gas pollution; nitrous oxide emissions, primarily from agricultural practices, contribute about 6 percent to the state's greenhouse gas pollution. Manufactured halocarbons, which include hydrofluorocarbons, perfluorocarbons, and suflurhexafluoride, account for the remaining 3 percent.

The model we used calculates only carbon dioxide (CO2) and methane (CH4) together represented as a CO2 equivalent (CO2e). The Global Warming Potential (GWP) of both CO2 and methane has been calculated in order to make comparisons between CO2 and methane. Methane is 21 times more potent as a greenhouse gas than CO2, thus the global warming potential of CO2 is 1, and methane is 21 (IPCC 1996). When methane and CO2 emissions are summed, they are referred to as CO2e, indicating that methane has been converted to CO2 equivalent.

Figure 4. Oregon Greenhouse Gas Emissions Sources in 2000



Source: Oregon Department of Energy

The model we used employs the inputs outlined in the Data Sources section above and emissions factors or "coefficients" to calculate total CO2 equivalent. A different coefficient has been calculated for electricity, natural gas, fuel oil, steam, gasoline, diesel, biodiesel, methane, and waste composition. The first step is to convert all sources of energy into MMBTUs (One Million British Thermal Units---see List of Acronyms below). Waste is kept in tons.

- Electricity: kWh x **0.003412** = MMBTU
- Natural Gas: therms x **0.1 =** MMBTU
- Fuel Oil: gallons x **0.147** = MMBTU
- Steam: klbs x **1.0** = MMBTU
- Gasoline: gallons x **0.125** = MMBTU
- Diesel: gallons x **0.139** = MMBTU
- Biodiesel B20: gallons x **0.139** = MMBTU
- Methane: therms x **0.1** = MMBTU
- Municipal Solid Waste: Tons

The second step, after all energy units are converted to MMBTUs, is to multiply a CO2 emissions coefficient by MMBTUs to calculate total metric tons CO2. For waste, a CO2 emissions coefficient is multiplied by metric tons to calculate the total metric tons CO2 emissions equivalent. There is a different coefficient for each type of waste. The coefficient for electricity varies depending on the year and subsequent power generation mix (see EWEB Coefficient Analysis section below).

- Natural Gas: MMBTU x **0.053** = Metric tons CO2
- Steam: MMBTU x **0.053** = Metric tons CO2 (uses the natural gas coefficient, because natural gas is used to produce the steam)
- Fuel Oil: MMBTU x **0.079** = Metric tons CO2
- Gasoline: MMBTU x **0.071** = Metric tons CO2
- Diesel: MMBTU x **0.073** = Metric tons CO2
- Biodiesel B20: MMBTU x **0.057** = Metric tons CO2 (calculated as 80% of the Diesel coefficient to reflect 20% of B20 as producing zero emissions)
- Methane (Combusted): MMBTU x **0.052** = Metric tons CO2
- Methane (Flare Gas): MMBTU x **0.055** = Metric tons CO2
- Municipal Solid Waste (paper and paper products): Tons x **1.210** = Tons CO2e
- Municipal Solid Waste (food waste): Tons x **1.130** = Metric tons CO2e
- Municipal Solid Waste (plant debris): Tons x (**- 0.161)** = Metric tons CO2e
- Municipal Solid Waste (wood, furniture, textiles): Tons x (**- 0.242)** = Metric tons CO2e
- Municipal Solid Waste (all other waste): Tons x **0.0** = Metric tons CO2e

Unless otherwise noted, the fuel coefficients were obtained from the Department of Energy, Form EIA-1605 Voluntary Reporting of Greenhouse Gases, Instructions, 2001. The municipal solid waste coefficients were provided by Fort Collins, CO, as developed by the CCP Greenhouse Gas Emissions Software (CCP Software 2004; Fort Collins 2003).

EWEB Coefficient Analysis

There is no standard electricity coefficient as the coefficient depends on the mix of energy sources used to generate the electricity. A coefficient was thus calculated for the Eugene Water & Electric Board (EWEB) based on EWEB's mix of electricity generation. EWEB's coefficients were provided by EWEB's Energy Resources Department for the year's 1994 to 2000. An average for these years was calculated and used for 2001 through 2004.

EWEB Coefficients*:

1994: **0.091** metric tons CO_2 / MMBTU
1995: **0.070** metric tons CO_2 / MMBTU
1996: **0.057** metric tons CO_2 / MMBTU
1997: **0.059** metric tons CO_2 / MMBTU
1998: **0.066** metric tons CO_2 / MMBTU
1999: **0.064** metric tons CO_2 / MMBTU
2000: **0.068** metric tons CO_2 / MMBTU
2001: **0.068** metric tons CO_2 / MMBTU
2002: **0.068** metric tons CO_2 / MMBTU
2003: **0.068** metric tons CO_2 / MMBTU
2004: **0.068** metric tons CO_2 / MMBTU

* EWEB's electricity coefficients are based on between 50-60% of electricity coming from hydropower, which is assumed to produce zero CO_2. However, as stated elsewhere, recent studies (Gaffin 2005; Graham-Rowe 2005; IPCC 2005) suggest that hydropower may not be CO_2 neutral and therefore, despite the belief held by many that the Pacific Northwest generates less CO_2 because of its use of hydropower, EWEB's CO_2 coefficient could be much higher than currently calculated.

List of Acronyms

CH4 – methane
CNG – compressed natural gas
CO2 – carbon dioxide
CO2e – carbon dioxide equivalent (methane & other gases are converted to CO2e based on GWP)
F – degrees Fahrenheit
Gal - gallon
GGE – gallon of gas equivalent
GHG – greenhouse gas
GWP – Global Warming Potential
HFC – hydrofluorocarbons
Klbs – thousand pounds
kWh – kilowatt hour
LED – light emitting diode
MMBTU – One Million British Thermal Units
MSW – municipal solid waste
PFC – perfluorocarbons
SF6 – suflurhexafluoride
Therms – 100,000 BTU (British Thermal Units)
VMT – vehicle miles traveled

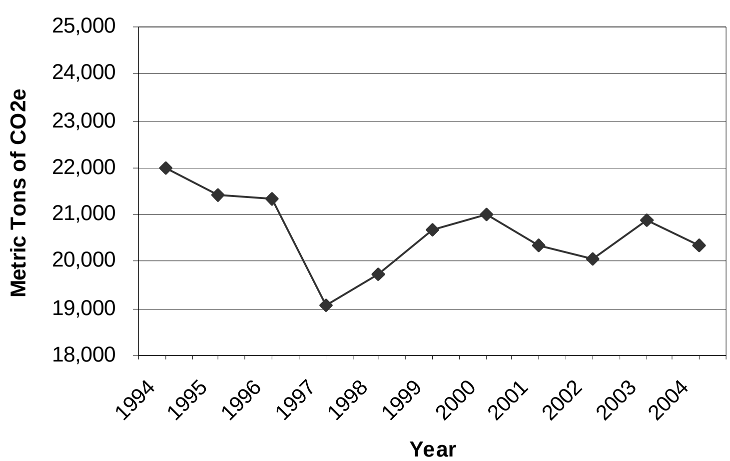
Greenhouse Gas Emissions and Trends

Figure 5 shows the City of Eugene's internal operations greenhouse gas emissions trends for 1994-2004 in total metric tons of CO2 equivalent (CO2e). Figure 5 shows a slight fluctuating trend in total metric tons CO2e between 1994 and 2004. Between 1994 and 1997, emissions drop by about 3,000 metric tons CO2e. Between 1997 and 2000, emissions increase by about 2,000 metric tons CO2e. Between 2000 and 2002, emissions again decrease by about 1,000 metric tons CO2e. Between 2002 and 2003, emissions increased by approximately 800 metric tons CO2e. Between 2003 and 2004, emissions again decreased by approximately 500 metric tons CO2e. Overall, between 1994 and 2004, emissions have decreased by 1,642 metric tons CO2e (- 7.5%).

The variability in emissions from year to year is primarily due to differences in wastewater treatment emissions, which are primarily from methane recovery. The larger the amount of methane generated, the larger the emissions. This accounts for the large drop in emissions between 1996 and 1997, when wastewater emissions dropped from 9783 to 7578 metric tons CO2e. The upward trend from 1997 to 1999 was due primarily to an increase in wastewater treatment emissions also. The slight increase from 1999 to 2000, however, was due to an increase in fleet emissions, when emissions increased from 2874 to 3565 metric tons CO2e due to an increase in the number of gallons of both gasoline and diesel. The decrease in emissions between 2000 and 2002 were due to overall decreases from most all sources (buildings, wastewater, fleets, and waste). The increase from 2002 to 2003 was due to increases in emissions from all sources except waste, which was assumed to have stayed the same. The decrease in emissions from 2003 to 2004 was due to both decreases in building emissions (from 7372 to 6870 metric tons CO2e) and fleet emissions (from 3560 to 3227 metric tons CO2e).

Emissions reductions between 2003 and 2004 for the building and fleet sources could be attributed to actions the City has taken to increase energy efficiency. See Part IV, the section titled City of Eugene Internal Operations Programs with Potential GHG Emissions Impact, for more information.

Figure 5. Eugene Internal Operations Greenhouse Gas Emissions Trends (1994-2004)



Future Projections: Without additional changes, it is likely that future emissions will follow a similar trend as we found from 1994-2004 of fluctuating increases and decreases with the overall trend being a gradual overall decline. Additional emissions reductions changes could decrease emissions at an even higher rate.

To determine the sources that contribute to total CO2e, emissions were calculated separately by source. Figure 6 shows the emissions trends per source (Buildings, Wastewater Treatment, Lighting, Fleets, and Municipal Solid Waste) between 1994 and 2004. Figure 7 shows the percentage breakdown per source for 2004 emissions. Wastewater treatment contributes the highest percentage of emissions at 44.7%, with buildings accounting for 33.8% of emissions.

Figure 6. Eugene Internal Operations Greenhouse Gas Emissions Trends Per Source (1994-2004)

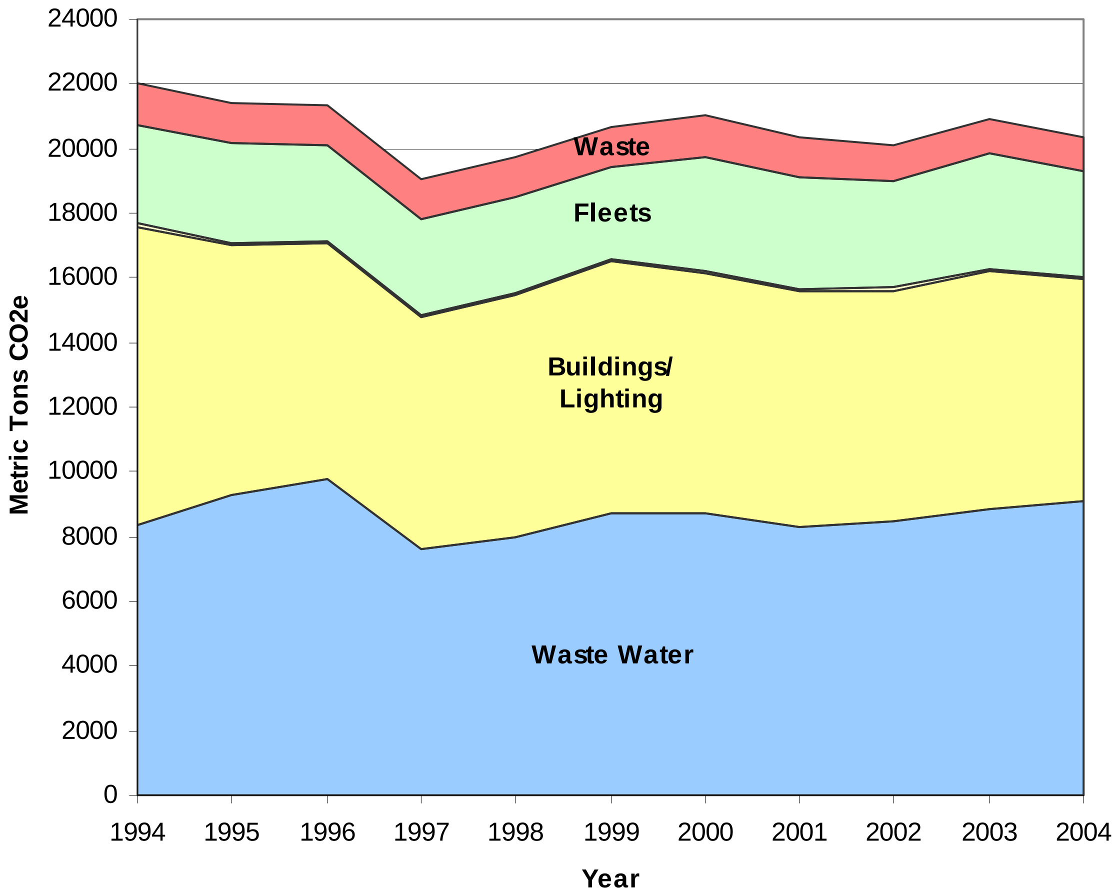


Figure 7. Eugene Internal Operations Greenhouse Gas Emissions Percentage Per Source (2004)

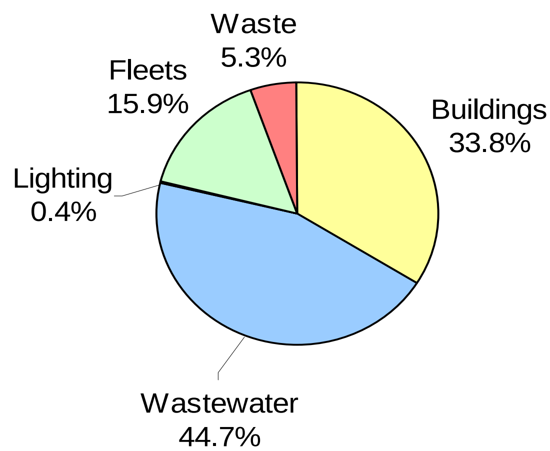


Table 1 shows the emissions trend data per source (Buildings, Wastewater Treatment, Lighting, Fleets, and Municipal Solid Waste) between 1994 and 2004. Table 2 displays other trends, including total square footage for Eugene's buildings, number of city employees, average annual temperature, and the population of the City of Eugene.

Table 1. Eugene Internal CO2e Emissions Data by Source (Metric Tons CO2e)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Waste Water	8324	9252	9783	7578	7966	8725	8718	8312	8467	8823	9101
Buildings	9273	7759	7294	7203	7480	7776	7415	7282	7147	7372	6870
Lighting	72	56	48	49	53	54	60	60	67	71	78
Fleets	3083	3102	2988	2988	2988	2874	3565	3442	3318	3560	3227
Waste	1242	1242	1242	1242	1242	1242	1242	1242	1075	1075	1075
Total	**21,993**	**21,411**	**21,354**	**19,060**	**19,729**	**20,670**	**21,000**	**20,337**	**20,074**	**20,902**	**20,351**

Table 2. Eugene Internal Data (Other Factors)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Other Factors											
Square footage (millions)	1.91	1.91	2.00	2.01	2.11	2.33	2.18	2.19	2.02	2.29	2.28
No.of Employees	1278	1320	1367	1313	1338	1388	1404	1430	1467	1475	1451
Ave. Annual Temp. (F)	-	-	-	53	53	52	52	52	53	54	54
Total City Population	-	-	-	-	-	-	137893	139297	140665	142185	-

Respectively figures 8, 9, 10, and 11 show trends in total square footage, number of local government employees, average annual temperature (F), and city population. With both square footage and number of local government employees, the trend is a slight increase upward. Average annual temperature began at 53 in 1997, dropped to 52 during 1999 to 2001, rose to 53 in 2002, and rose again to 54 in 2003 and 2004.

Figure 8. Eugene Internal Operations Building Square Footage (1994-2004)

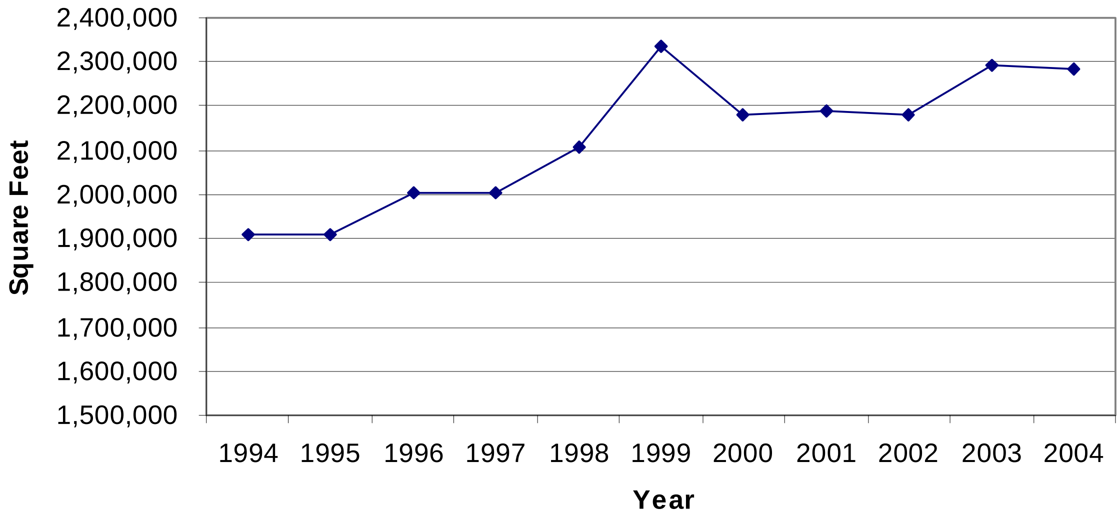


Figure 9. Eugene Internal Operations (City) Employment (1994-2004)

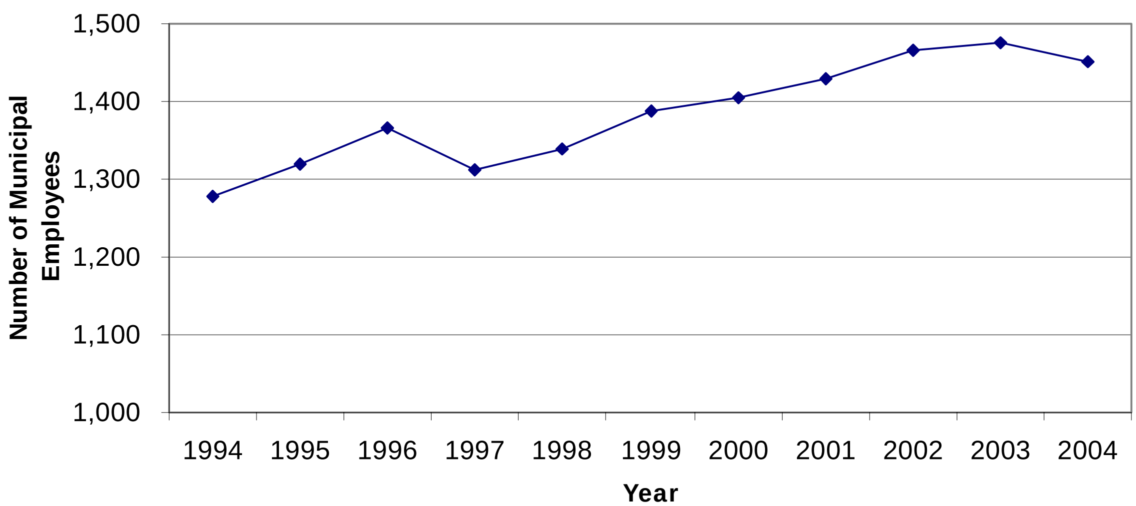


Figure 10. Eugene Average Annual Temperature (F) (1997-2004)

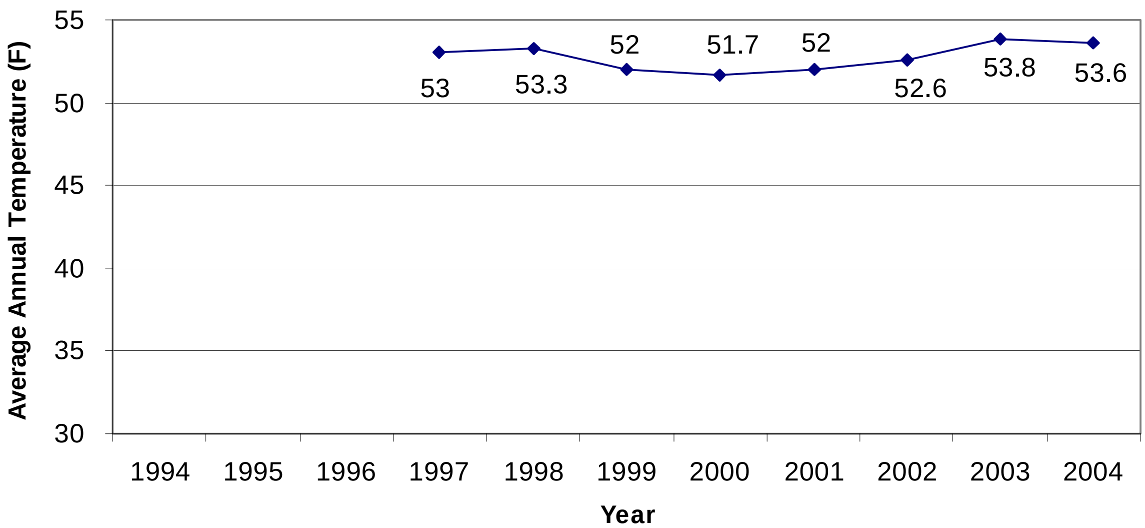
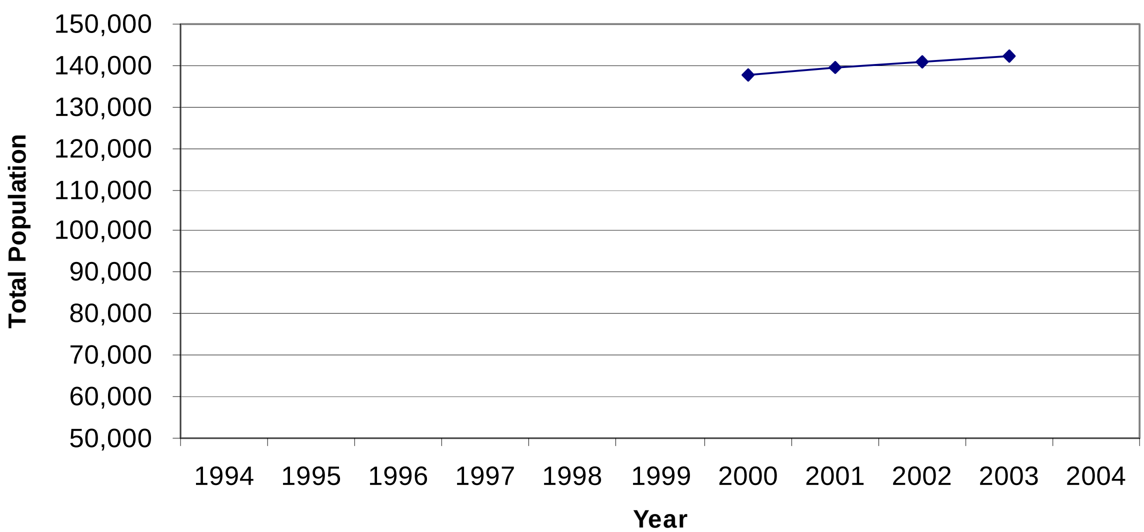


Figure 11. Eugene City Population (2000-2003)

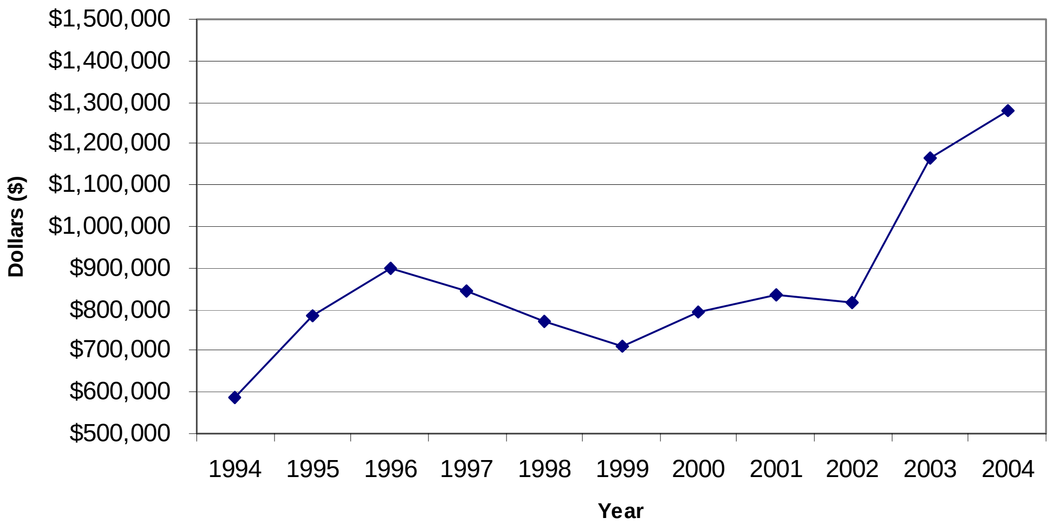


Cost data was available for energy sources for all sources of emissions and municipal solid waste, except for methane recovery sources. See Table 3. Figure 12 shows the total cost of energy and municipal waste disposal for the years 1994 to 2004. The trend in Figure 12 is somewhat similar to the greenhouse gas emissions trend shown in Figure 5, but the total cost does not always correlate with the total metric tons CO2e produced. This could be due to differences in the cost of energy sources from one year to another. Also, data was not provided for the cost of burning or flaring methane at the wastewater treatment plant. This is important because this represents 25% of all greenhouse gas emissions for the City of Eugene's internal operations. If wastewater treatment cost was represented, then Figure 12 would probably more closely correlate with Figure 5.

Table 3. Eugene Internal Cost of Energy and Municipal Waste Disposal Data by Source

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Buildings	***1,113,138***	***1,117,422***	***1,157,238***	***1,205,656***	***1,131,877***	***1,228,377***	***1,218,847***	***1,314,476***	***1,617,081***	***1,599,422***	***1,695,177***
Electricity (kWh)	764,797	776,785	780,469	825,019	758,902	794,307	778,755	757,339	1,055,974	1,088,793	1,160,426
Natural Gas (therms)	177,400	161,208	156,859	145,085	184,449	211,618	230,387	331,729	339,628	329,210	336,748
Fuel Oil (gals)	1,359	937	986	692	460	101	-	-	-	-	-
Steam (klbs)	169,582	178,492	218,924	234,860	188,066	222,351	209,705	225,408	221,479	181,419	198,003
Lighting	***12,843***	***13,371***	***13,901***	***13,713***	***13,272***	***13,611***	***16,439***	***19,078***	***25,930***	***27,938***	***31,529***
Park Lighting (kwh)	12,843	13,371	13,901	13,713	13,272	13,611	16,439	19,078	25,930	27,938	31,529
Fleets	***272,723***	***280,915***	***347,774***	***347,774***	***316,231***	***248,744***	***354,820***	***386,159***	***361,646***	***436,217***	***535,095***
Unleaded gasoline (gal)	169,940	175,045	216,706	216,706	197,051	154,998	221,097	240,625	225,350	271,817	333,430
Diesel (gal)	102,783	105,870	131,068	131,068	119,180	93,746	133,723	145,534	136,296	164,400	
BioDiesel (gal)	-	-	-	-	-	-	-	-	-	-	201,665
Wastewater Treatment	***208,813***	***399,358***	***444,897***	***390,995***	***348,644***	***358,541***	***329,490***	***339,238***	***334,132***	***603,375***	***618,166***
Electricity (kWh)	208,813	399,358	444,897	390,995	348,644	358,541	327,459	328,851	323,416	592,592	605,825
Natural Gas (ccf)	-	-	-	-	-	-	2,031	10,387	10,716	10,783	12,341
Municipal Solid Waste	***91,776***	***91,776***	***91,776***	***91,776***	***91,776***	***91,776***	***91,776***	***91,776***	***97,083***	***97,083***	***97,083***
TOTAL COST	**$ 586,155**	**$ 785,420**	**$ 898,348**	**$ 844,258**	**$ 769,923**	**$ 712,672**	**$ 792,525**	**$ 836,251**	**$ 818,791**	**$ 1,164,613**	**$ 1,281,873**

Figure 12. Eugene Internal Operations Total Cost of Energy and Municipal Waste Disposal (1994-2004)

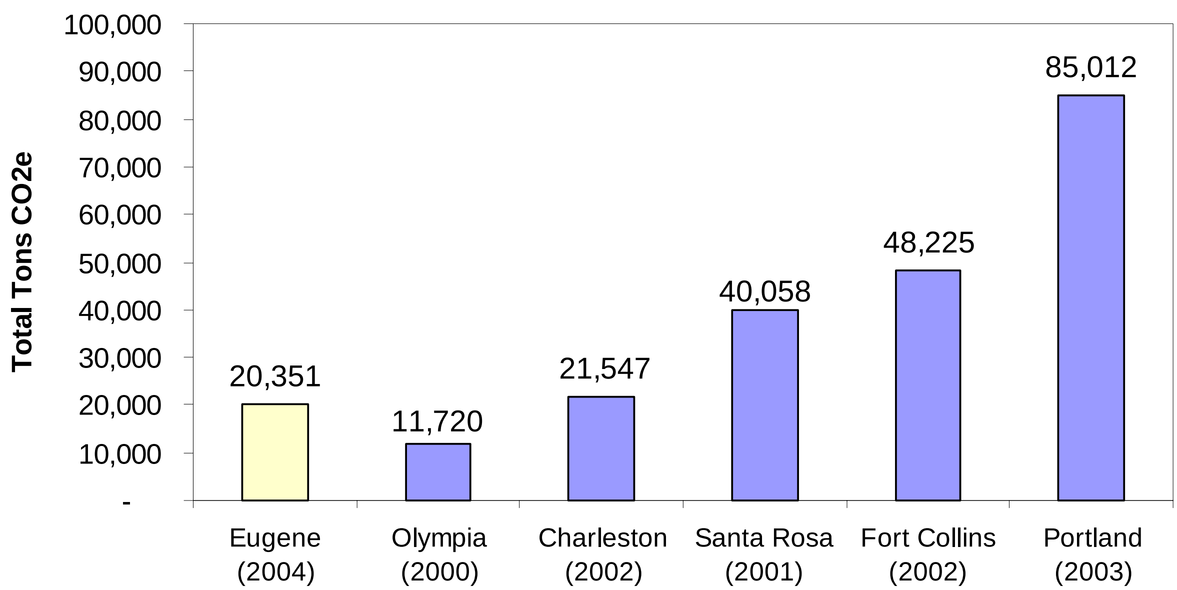


Referencing Greenhouse Gas Emissions From Five Other Local Governments

Greenhouse gas emissions data for five local governments (internal operations) are provided here as a reference. It should be noted that each of the five local governments used slightly different methodologies in assessing total CO2 emissions and each community differs in population, size of city government, and climatic conditions. Thus this information should be used for reference purposes only, not as a direct comparison, to provide an idea of other city's emissions. It appears, however, that total emissions nearly correlate with the size of the population that each local government serves. As population increases, the emissions increase at a similar rate.

Data for the City of Olympia, WA was available for 2000, data for the City of Santa Rosa, CA was available for 2001, data for the Cities of Fort Collins, CO and Charleston, TN was available for 2002, and data was available for the City of Portland for 2003. Data is also provided for Eugene's 2004 emissions. See Figure 13.

Figure 13. Greenhouse Gas Emissions (TonsCo2e) for Six Local Governments (Internal Operations)



Sources: (City of Olympia 2005; City of Portland 2005; Sonoma 2003; CCP 2003; City of Fort Collins 2003)

Table 4 provides population, employees, square footage, and greenhouse gas emissions source data for each of the five local governments and Eugene. Population, employee, and square footage data was provided to determine how emissions might differ with these factors. Employee and square footage data was only available for Eugene and Fort Collins.

Table 4. Reference Data and Greenhouse Gas Emissions for Six Local Governments (Internal Operations)

City	Year	Population	Number of Employees	Square Footage	Buildings/ Lighting	Water/Waste Water	Fleets	Employee Commutes	Municipal Solid Waste	Total CO2e (tons)
Eugene	2004	142,185	1451	2,283,032	6948 34%	9101 45%	6870 34%	-	9101 45%	20,351
Olympia	2000	42,514	-	-	2553 22%	6751 58%	2416 21%	-	-	11,720
Charleston	2002	96,421	-	-	13073 61%	-	4092 19%	3946 18%	430 2%	21,547
Santa Rosa	2001	147,595	-	-	10221 26%	20,492 51%	6,554 16%	2712 7%	80 0.2%	40,058
Fort Collins	2002	126,848	1200	744,144	18581 39%	15369 32%	13860 29%	-	415 1%	48,225
Portland*	2003	529,121	-	-	-	-	-	-	-	85,012

Sources: (City of Olympia 2005; City of Portland 2005; Sonoma 2003; CCP 2003; City of Fort Collins 2003)
*Sector data for Portland not available at this time.

In general, the five local governments offered as reference points attempted to quantify sources and calculate total emissions from all sources. However, different methods were used for identifying sources and calculating emissions. For example, only Charleston and Santa Rosa included calculated emissions from employee commutes. The City of Eugene hopes to include this data in the future. Also, Olympia did not have emissions data for municipal solid waste, and Charleston did not have emissions data for water/wastewater. It appears that this data may have been included in Charleston's Buildings/Lighting category.

Potential Greenhouse Gas Emissions Targets

As stated by the Cities for Climate Protection (CCP), "adopting a target and timetable for [emissions target] achievement is essential to foster not only political will but also to create a framework that guides planning and implementation of measures." Many local governments are adopting targets to reduce greenhouse gas emissions based on the Kyoto Protocol. The Kyoto Protocol calls for industrialized nations to cut heat-trapping greenhouse gas emissions by an average of 5.2% below 1990 levels by the years 2008-2012 (UNFCCC 1998). Some CCP participants are striving to adopt the "Toronto Target" to reduce GHG emissions by 20% from 1990 levels by the year 2005 or 2010 (CCP 2005). However, many climate change scientists state that both of these targets do not go far enough and will not make a significant impact on current global warming or climate change trends. Many scientists believe that a reduction in greenhouse gas emissions of 70% below 1990 levels will be necessary to stabilize atmospheric conditions. Nevertheless, using the Kyoto or Toronto targets provide a good initial focal point for local GHG reduction plans. The lessons learned from achieving these goals may prove very beneficial in shooting for the 70% reduction level in the future.

The City of Eugene has already achieved over a 5.2% reduction in CO2 emissions. Between 1994 and 2004, it has decreased emissions by 7.5%. For the City of Eugene to achieve a 20% reduction in CO2 emissions by 2010 (using 1994 emissions as the baseline because we did not have 1990 data), it would need to reduce its emissions to 17,594 metric tons CO2e. This does not seem like an unreasonable target as the City is already implementing or planning to implement numerous measures to reduce CO2e emissions. For the city of Eugene to achieve a 70% reduction in CO2 emissions from 1994 emissions, it would have to reduce its output to 6,423 metric tons CO2e.

Further Analysis to Be Completed

Lighting and Employee Commuting Data

At the time of this report, street lighting, traffic signal, and employee commuting data was not available from the City of Eugene. This data may moderately increase the City's total metric tons CO_2e emissions.

Sequestration Efforts

The City of Eugene has sequestration programs in place including a wetland mitigation bank, increased vegetation along waterways, a street tree program to increase the number of trees within the Eugene City limits, and parks and open space improvements. These efforts could be considered as sequestration sinks for CO_2 and could be "subtracted" from Eugene's total calculated metric tons CO_2 emissions. Quantification of these efforts has not yet been completed, but could be a useful exercise in the future.

Community-Wide Baseline Emissions Assessment

A greenhouse gas emissions assessment has not yet been completed for the community of Eugene as a whole including total emissions from the commercial, industrial, and residential sectors, as well as the University of Oregon, City of Springfield (internal government operations and community-wide) and Lane County (internal government operations and county-wide). These assessments are planned to be completed by the end of 2005, assuming data can be obtained.

PART IV: GREENHOUSE GAS MITIGATION AND ADAPTATION OPTIONS

Introduction

After baseline emissions are calculated, the third step in developing a climate protection plan is to determine potential greenhouse gas mitigation and adaptation options. Five areas are commonly examined: transportation, energy efficiency, renewable energy, waste reduction and recycling, and forest and carbon sequestration. As previously mentioned, research shows that many of these options can lead to cost savings, increased efficiency and productivity, and business and job retention and expansion. Thus, many climate protection options can help local governments provide services and meet their priorities in a manner that, almost as a side benefit, reduces greenhouse gas emissions.

The first section below describes some of the programs the City of Eugene has already implemented to reduce emissions. The next section offers preliminary recommendations for how the City of Eugene can enhance its current efforts. The third section offers insights into how climate protection options can link with and help the City of Eugene's meet its current priorities. The fourth section offers examples of greenhouse gas reduction strategies implemented within other U.S. communities. The last section offers examples from leading private companies.

City of Eugene Internal Operational Programs with Potential GHG Emissions Impact

Since 1992, the City of Eugene reported numerous internal actions that have reduced GHG emissions, such as energy efficiency and energy use reduction programs, CO2 sequestration programs, and solid waste reduction and recycling programs. As provided by city staff to us, the following is an outline of these programs (City of Eugene 2005). Specific energy efficiency and use reduction programs can be found in Appendix D. Energy efficiency efforts include upgrading lighting systems, HVAC systems, and motors, and installing exterior insulation, replacing windows, and providing low wattage space heaters.

<u>Energy Efficiency and Use Reduction Programs</u>

- Energy Efficiency Program
  - Ongoing in City buildings since 1994
  - Numerous large projects came on-line 2000-2001
  - Overall energy savings of over 20% based on 1995 usage
- Biodiesel
  - B20 used in all diesel City vehicles since Aug 2003.
- Hybrid Vehicles
  - First hybrid vehicles purchased in 2001, when first available.
  - 15 hybrid vehicles are now in the fleet.
- Wastewater Treatment Plant
  - Methane recovery and electricity generation ongoing since 1992
  - Output of methane recovery generators was doubled in 1999

Major efficiency improvements made to equipment in 96-97 and 02-03.
In 2006, the addition of a catalytic converter is planned for the methane fired engine.

CO2 Sequestration Programs

Wetland Mitigation Bank

In place since 1993, 3000 acres banked, approx. 900 acres restored.

Open Waterways Program improvements

Change in management of waterways has resulted in increased vegetation.

Street Tree Program (Neighborhoods)

In place since 1992, 7000 trees planted in Eugene City limits.

Parks and Open Space improvements

Ongoing since passage of funding in 1999

Solid Waste Reduction and Recycling Programs

Green Team

Paper use reduction effort began in 2004

Recycling Program

Solid waste recycling increased in 2004 due to commingled collection

City of Eugene Internal Government Emissions Reduced or Averted

Data for quantifying emissions reductions or emissions averted was available, in part, for two sources of emissions, fleets and wastewater treatment. Table 5 describes these trends. As previously discussed, the City of Eugene began using B20 in all diesel City vehicles in August 2003. Biodiesel is considered to be emissions neutral. Therefore, it was determined that 359 metric tons of CO2e were reduced or averted from using B20 verses standard diesel. This was done by calculating what the emissions would have been per gallon of regular diesel and subtracting what the emissions actually were from using B20.

Table 5. Eugene Internal Emissions Reduced or Averted (Metric Tons CO2e)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Fleets											
Switch to B20 Biodiesel	0	0	0	0	0	0	0	0	0	0	359
Wastewater Treatment											
Methane Combustion	46,533	45,774	51,628	37,335	41,731	45,530	47,804	47,932	46,952	47,866	48,348
Electricity Generated from Methane Combustion	1955	1606	1276	1241	1432	1229	1580	1511	1431	1471	1318
Total	**48,488**	**47,380**	**52,904**	**38,577**	**43,162**	**46,759**	**49,383**	**49,443**	**48,383**	**49,337**	**50,025**

A large amount of CO2e emissions at the wastewater treatment plan have been averted annually since 1992, when methane recovery was implemented. Methane recovery involves capturing the methane gas generated by wastewater treatment and either flaring the gas or burning it in an internal combustion engine to produce electricity, which converts the methane (CH2) into CO2. In addition, the electricity produced offsets electricity provided by a local utility. For example, the City of Eugene's wastewater treatment facility generates fifty percent of the electricity used at the facility. The City of Eugene burns methane in two engines and a boiler, and flares any remaining methane. The amount of CO2e averted from flaring or burning methane is quite significant, because pure methane released into the atmosphere is considered to have a global warming potential that is 21 times greater than CO2 (IPCC 2006). A large portion of greenhouse gas emissions reductions have occurred throughout the world from capturing and burning methane from both wastewater treatment facilities and landfills.

It is important to note, that although burning methane at the wastewater treatment plant reduces greenhouse gas emissions significantly by offsetting the release of pure methane, and offsets a large amount of electricity, burning methane still produces a large amount of CO2 and contributed to roughly 25.7% of Eugene's total greenhouse gas emissions in 2004.

Preliminary Recommendations for Future Emission Reduction Efforts

As shown in Figure 7 (in Part III), wastewater accounts for 44.7% of Eugene's internal operations CO2e emissions, and buildings account for almost 33.8%, leaving fleets, solid waste, and park lighting with the remaining 21.5%. Therefore, the greatest leverage for reductions in total CO2 emissions may be found in additional measures being applied to the wastewater treatment plant and building sources.

Although 44.7% of emissions are from wastewater treatment, 25.7% of emissions are directly related to methane recovery efforts. As explained in the section above, methane recovery involves capturing the methane gas generated by wastewater treatment and either flaring the gas or burning it in an internal combustion engine to produce electricity, which converts the methane (CH2) into CO2. Even though methane recovery is necessary and important, and emissions would have otherwise been more than 3 times as much in 2004 if the methane had not been recovered, consideration should be given to steps that can reduce the total amount of methane generated at the wastewater treatment plant.

It is important to note that emissions from the capture and combustion of methane could increase due to either a change in through-put of wastewater for the plant or more efficient capture of methane. More efficient capture of methane is good and the recommendations that follow refer primarily to decreasing the through-put of wastewater into the plant.

Overall, building emissions have decreased between 1994 and 2004. Energy efficiency steps in city owned buildings have been implemented, and it is likely that additional efforts to improve energy efficiency in buildings will continue to make significant impacts on internal operations CO2e emissions.

Below are our preliminary recommendations for enhancing the City of Eugene's efforts to reduce greenhouse gas emissions. Note that this is undoubtedly not a complete summary of the steps the city has already taken. Therefore, some of the recommendations may be duplicative and may already be in motion.

Wastewater

- Shift to renewable energy such as solar to power all or part of wastewater treatment system.
- Increase educational efforts to increase waster use efficiency and decrease total wastewater generated for the communities that the wastewater treatment facility serves (both the City of Eugene and Springfield)
- Increase educational efforts to reduce the amount of organics in the wastewater stream.
- Upgrade to high efficiency motors and pumps where this has not already been completed.

Buildings

- Utilize comprehensive green building techniques (in current and future projects) and require all new buildings be LEED certified to the highest levels possible.
- Establish high level energy efficiency standards for each building upgrade.
- Require Energy Star ratings for all 'white goods' (appliances) purchased or used.
- Where not already occurring, purchase green power (wind) from EWEB for all buildings.
- Adopt localized distributive energy mechanisms (each building or cluster of buildings would become energy self sufficient through a combination of dramatically increased efficiency measures and on-site solar or other renewable energy systems).
- For buildings that currently use EWEB steam as a heat source, upgrade to localized gas boiler, which could be as much as 10-25% more efficient, or switch to an electric heat pump system, which is also much more efficient than steam.

Fleets:

- Increase ratio of biodiesel to diesel in vehicles aiming toward B100.
- Increase purchase and use of hybrid vehicles.
- Consider use of small electric vehicles, powered by green energy from EWEB, on-site solar, or other renewable energy systems, for short trips around town by employees.
- Increase transportation demand management and use efficiency strategies including use of Flex Cars and similar options where possible.
- Create satellite maintenance areas.
- Adapt more stringent fuel efficiency standards in fossil fuel powered vehicles.
- Look into using a mixture of ethanol and gasoline in vehicles, which may reduce CO_2e emissions by as much as 30%, as well as provide other air quality benefits.
- Increase fuel consumption awareness/education among city employees.

Municipal Solid Waste

- Set very high waste reduction goals such as zero waste to landfills and incinerators such as aiming toward Zero Waste to landfills and incinerators within 10-20 years.

Park Lighting

- Invest in renewable energy (solar etc) for park lights.

Linking the Priorities of Eugene Citizens with Climate Protection

Climate protection options can help local governments achieve their existing priorities. In 2004, the City of Eugene contracted with the University of Oregon Survey Research Laboratory (OSRL) to conduct the "City of Eugene Community Survey." The goals of the survey were to obtain valid and reliable information from residents on the quality of life in Eugene, community priorities and values, and the quality of services provided by the City. OSRL implemented a phone survey of 401 randomly selected Eugene households in November 2004. The following section discusses how climate protection options can be linked with some of the outcomes of the OSRL report and thus help the City of Eugene address its citizen's priorities.

Eugene Resident Priority #1 - Economic Development and Unemployment

The 2004 OSLR report identified economic development and unemployment as two of the most important problems facing Eugene residents. Thirteen percent of the respondents felt that economic development was an important issue, up from 9% in 2003. Seven percent of the respondents felt that unemployment was an important issue, down from 12% in 2003. Sixty percent of respondents feel that their economic opportunities in Eugene during the past five years has gotten better or stayed the same, compared with 50% in 2003, and 56% in 2002. Thirty six percent feel the situation has worsened, compared with 45% in 2003 and 35% in 2002.

Research completed by the UO Program for Watershed and Community Health in 2003 and 2004 identified a number of emerging business opportunities in the field of sustainable development that could expand living wage job opportunities while producing goods and services that reduce greenhouse gas emissions. These include: renewable energy generation, energy efficiency, energy efficient buildings, green building, waste-based economic development, organic and sustainable foods, and sustainable agriculture and forestry. By prioritizing the expansion of existing firms in these sectors and/or incubating and recruiting new firms with the goal of establishing industry clusters in these fields, The City of Eugene could address the top priority of local residents while also, almost as a side benefit, help reduce GHG emissions. The examples below summarize these growing sectors.

Renewable Energy

The renewable-energy industry includes energy sources that will not be depleted as electricity for heat energy is generated from them. Analysts generally consider renewable energy sources to be wind, solar, geothermal, biomass, and small hydropower (although recent research suggests that hydropower may not be carbon neutral as many in the Pacific Northwest believe it to be).

According to a study In Washington, Oregon, and British Columbia, clean energy is currently a $1.4 billion dollar industry. This market is anticipated to grow even larger as the nation adopts more strict standards for clean energy and the risks to the economy associated with global warming and abrupt climate change become move evident. However, even if government does nothing to support these new industries, this sector is expected to grow to a total of $2.5 billion a year over the next 20 years and over 12,000 jobs in the region. The Pacific Northwest is already a world leader in fuel cells, and has the ability to develop global leadership in power systems and solar photovoltaics as well. Wind, energy efficiency, and biomass energy sources also offer very substantial economic development potential in the region. Washington firms associated with solar energy generated sales of $71 million and employed more than 420 people (see Table 6 below).

Making the development of a renewable energy industry cluster in Eugene/Lane County a priority may generate a significant number of new businesses and jobs while also helping to reduce greenhouse gas emissions.

Table 6: Washington's Renewable Energy Sectors, 1997

	Firms	Revenues ($1,000)	Wages ($1,000)	Jobs
Biomass, Biofuels, Muni. Solid Waste	26	54,240	325	11,940
Electric Vehicles	6	3,026	16	570
Geothermal	10	124	0	12
Small-scale hydroelectricity	21	15,452	119	5,384
Solar, Elec. Storage, Inverters	69	71,083	424	13,692
Wind	6	2,255	20	903
General	2	635	3	202
Total	140	146,815	907	32,703

Source: ECONorthwest, 1998

Example: Local Benefits From Wind Power: Although Lane County may not be ideal for wind power, EWEB sells it and it provides a good example of the economic development potential of renewable energy. *Each kilowatt of wind power represents about $1,000 in tax base for the county in which it is generates.* Wind developers commonly pay 1-3% of their value annually in property taxes. Since wind plants are among the most capital intensive of electrical generators – a wind turbine's "fuel" is embodied in the up front investment – they can pay three times more property tax than comparable natural gas turbines.

Another promise borne on the wind is new jobs. During construction, usually around *6-8 months, a 75 mW wind plant might require 200 or so workers, including laborers, electricians and heavy equipment operators.* Permanent operations and maintenance positions are also created. For example, Iowa's Storm Lake wind plant keeps a crew of 20 busy, and pays them $16/hour. For a rural area, that is a small but significant job base. The New York State Energy Research and Development Authority estimates wind energy produces 27% more jobs per kilowatt hour than coal and 66% more jobs than natural gas. Wind plants also generate economic spillover effects – one study showed $500,000 in local purchases from a 100 mW installation.

Biomass Case Studies: Fuels for Schools in Montana: Though often overshadowed by biofuel and wind initiatives, biomass projects are also playing an important role in Montana's energy future. As noted in a January 17 Missoulian opinion, "Wood from western Montana forests is a ready, relatively inexpensive but underused source of heating fuel for schools and other larger buildings." Noting the highly-touted Fuels for Schools program, the paper points out, "While we're saving money on institutional heating costs by burning wood, we'll also be paying local loggers and truckers money that now goes to Saudi princes. And buying this wood for fuel –

even at a substantial savings over oil – could help subsidize the cost of sound forest stewardship."

The second Fuels for Schools project in the state is saving big money in Philipsburg, where the school district's January heating expense plunged to a mere $467 from December's bill of $8,000. Thanks to the highly efficient design, the 181 tons of chips burned in January left only 80 gallons of ash. The boilers produce less than 3% of wood particulates and methane, less than 5% carbon monoxide and less than 40% of the nitrous oxide of an equal amount of free burning slash. The program's business plan includes the current demonstration phase, where biomass burners modeled after a pilot project in Darby are established in several towns, including Victor, Philipsburg and Thompson Falls.

Thompson Falls Public Schools, the third western Montana school district to climb on the national biomass bandwagon, recently accepted a $200,000 federal grant to help convert their older diesel-burning boiler to a biomass boiler fueled by wood waste from a local lumber mill plus forestry slash. The biomass heat will take care of about 80% of the campus' total heat bill.

Some $1.29 million in new funding was recently allocated for elementary and secondary schools in Kalispell, Troy, and Townsend, the University of Montana-Western in Dillon, and a hospital in Lewistown. Noted Sen. Conrad Burns (R-MT), "These clean biomass systems are saving our local schools and communities thousands of dollars in winter heating costs and creating a market for small-diameter timber."

Example: The Apollo Project: The New Apollo Project is a $300 billion, public-private program to create three million new, clean energy jobs to free America from foreign oil dependence in ten years. It is a program that reinvests in the competitiveness of American industry, rebuilds our cities, creates good jobs for working families, and ensures good stewardship of both the economy and our natural environment. The new Apollo Initiative will achieve these benefits by pursuing four broad strategies:

- *Diversify our energy sources*: making America less dependent on foreign oil, while making energy more secure, more affordable and reliable, and less polluting

- *Invest in the industries of the future*: promoting new technology, improving manufacturing processes, and expanding markets for American durable goods.

- *Promote construction of high performance, energy efficient buildings*: saving money and rebuilding more livable, more equitable, and healthier environments, and

- *Drive investment in cities and communities*: renewing our commitment to building smart public infrastructure for transportation, energy, and other vital public services.

Detailed analysis of the potential economic benefits reveals the promise of Apollo. A $30 billion investment per year for 10 years would provide the following benefits:

- Add more than 3.3 million jobs to the economy
- Stimulate $1.4 trillion in new Gross Domestic Product
- Stimulate the economy through adding $953 billion in Personal Income and $323.9 billion in Retail Sales
- Produce $284 billion in net energy cost savings

The new Apollo Initiative will also create high-skilled, high-wage jobs:

- Investments in improving the performance of our existing energy system create good jobs in new construction, and improved maintenance and operations.

- Increasing incentives for energy efficiency also create new construction investment and good jobs retro-fitting buildings. Energy efficiency is far more labor intensive than generation, creating 21.5 jobs for every $1 million invested, compared to 11.5 jobs for new natural gas generation.

- Renewable energy creates more jobs than other sources of energy, four times as many jobs per megawatt of installed capacity as natural gas and 40% more jobs per dollar invested than coal. Most of these jobs will be in the manufacturing, a sector of the economy that has been hemorrhaging jobs since 2001.

- New transit system starts, maintenance of the nation's passenger train system, development of regional high speed rail networks, and improvements in the nation's roads and highways will generate good jobs in basic industries. Infrastructure investments also guarantee that spending is made locally, directly stimulating the domestic economy, supporting small business and regional labor markets.

Energy Efficiency

The energy efficiency industry designs, manufactures, installs, and maintains facilities, equipment and processes that reduce the amount of energy consumed per unit of output or consumption.

In a report for the Washington Department of Community, Trade, and Economic Development, ECONorthwest found that the state's energy-efficiency industry generated annual sales of about $780 million. The industry employed approximately 2,900 workers, who earned annual wages of $128 million, with an average wage of $44,000. The analysis took a conservative approach to identifying firms in the industry and, hence, actual activity and employment in the industry probably are larger.

As with renewable energy, making the expansion of an energy efficiency industry cluster in Eugene/Lane County a priority may generate a significant number of new businesses and jobs.

Table 7: Washington's Energy-Efficient firms, 1997

	Firms	Revenues ($1,000)	Wages ($1,000)	Jobs
Consultants	11	4,553	1,382	38
Controls	13	122,347	13,089	308
Electrical suppliers and contractors	19	56,980	13,022	333
Energy service companies & engineers	47	430,901	67,814	1,292
Heating, ventilation, air conditioning	8	17,558	5,025	106
Lighting	16	116,233	20,952	652
General	20	28,343	6,593	165
Total	134	776,916	127,877	2,895

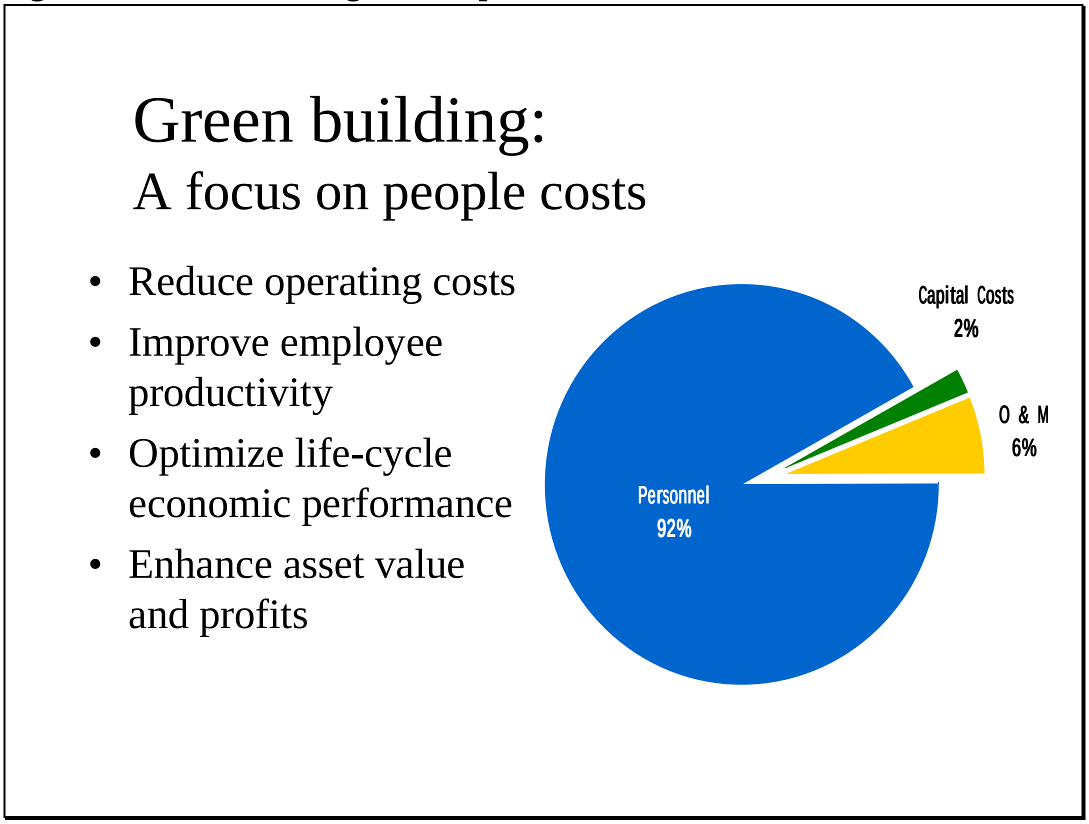
Source: ECONorthwest, 1998

Green Building

A growing stream of research suggests that the use of green building practices for design, construction, and landscaping helps cut greenhouse gas emissions, reduce operating costs and save money, and enhance the productivity of workers in commercial buildings while increasing the enjoyment of those who live in residential green buildings. For example, one study found that, based on 2001 energy costs, by incorporating green building practices, residents in Washington and Oregon could save more than $90 million each year in energy, water, and construction-related costs (ECONorthwest). A concentrated effort to conserve electricity would save about 800 megawatts. At the average retail rate in 2001, this conservation would save residential and commercial consumers $77 million per year. Region-wide water conservation strategies in Washington and Oregon would result in a decrease of 14.9 billion gallons of water each year. Water consumers would have a net savings of $12 million annually on their water bills.

However, most of the benefits of green building are produced by the affects on the “people costs” associated with a facility. Figure 14 shows that only 2% of the life cycle costs of a building are associated with construction and only 6% are associated with operating costs. A full 92% of the costs of a building are associated with personnel. Research shows that green building practices and technologies reduce operating costs, improve employee productivity, and in other ways generate significant economic benefits.

Figure 14: Green Building and People Costs



Source: City of Portland

The new library and other buildings owned by the City of Eugene have adopted green building standards. Making it a priority for all new buildings and all retrofits to meet high LEED standards would generate new jobs in the building trades and in commercial and residential materials and product development while also reducing the city's greenhouse gas emissions.

Energy Efficient in Public Buildings

Extensive research has shown that energy efficiency practices in public buildings can reduce wasteful consumption, improve productivity of employees, and create jobs in the process. A summary of the potential savings if efficiency practices were adopted at public buildings throughout Oregon and Washington are provided below.

Making it a priority for all new buildings and all retrofits to meet high energy efficiency standards would generate new jobs in the building trades while also reducing the city's greenhouse gas emissions.

Table 8: Cost Savings and New Jobs from Adoption of Energy Efficiency Practices: Government Office Buildings, Hospitals, and Schools

	No. Employees	Annual Energy Cost ($ millions)[a]	Potential Cost Savings ($ millions)[b]	Potential New Jobs from Savings[c]
Oregon				
State Government[d]	24,105[e]	$13.84	$3.04	20
Universities/Colleges	13,381[e]	$12.40	$2.73	50
Local Government[d]	51,122[e]	$29.35	$6.46	85
Elem./Sec. Schools	71,010[e]	$65.82	$14.48	285
Hospitals	40,365[e]	$98.10	$21.58	265
Oregon Total	**199,983**	**$219.50**	**$48.29**	**710**
Washington				
State Government[d]	43,234[f]	$25.29	$5.56	35
Universities/Colleges	33,990[f]	$32.11	$7.06	130
Local Government[d]	78,904[f]	$46.16	$10.16	125
Elem./Sec. Schools	139,275[f]	$131.57	$28.95	655
Hospitals	55,364[f]	$137.20	$30.18	355
Washington Total	**350,787**	**$372.33**	**$81.91**	**1300**
Total	**550,770**	**$591.84**	**$130.20**	**2010**

[a] Numbers based on these assumptions: (a) electricity prices = $.052 per kWh (Oregon,) and $.053 per kWh (Washington); and (b) energy use per 1,000 employees = 11,039,000 kWh (state and local government), 48,739,000 kWh (hospitals), 17,824,000 kWh (elem./sec. schools and universities) Source: ECONorthwest with data from the EIA, "Estimated U.S. Electric Average Revenue per Kilowatthour to Ultimate Consumers by Sector", and "1995 Commercial Buildings Energy Consumption Survey".

[b] Assumes 22 percent savings (High-Performance Commercial Building Systems Program, Lawrence Berkeley National Laboratory).

[c] Assumes labor's share of savings approximate its estimated current share of total costs per sector (assumptions and sources available upon request). Oregon: state government 25%; universities/colleges 52%; local government 45%; elem./sec. schools 57%; hospitals 43%. Washington: state government 25%; universities/colleges 67%; local government 45%; elem./sec. schools 63%; hospitals 45%.

Assumes mean earnings per worker per sector (sources: same as no. employees). Oregon: state government $35,823; universities/colleges $33,900; local government $34,764; elem./sec. schools $29,120; hospitals $35,202. Washington: state government $38,533; universities/colleges $35,882 local government $37,909; elem./sec. schools $27,778; hospitals $39,019. Calculations reflect rounding.

[d] Refers to the "Public Administration" sector of the state and local governments.

[e] Source: "1999 Oregon Covered Employment & Payrolls," State of Oregon Employment Department.

[f] Source: "1999 Employment and Payrolls in Washington State by County and Institution," Washington State Employment Security.

Waste-Based Economic Development

Diverting waste material from landfills or incinerators for use in products and services creates new businesses and jobs while reducing the waste and consequence greenhouse gas emissions produced by landfills and incinerators. One study found that currently, there are over 400 such businesses in Oregon that add value to materials previously considered "waste" through reuse, manufacturing, and recycling. These firms vary from grocers, to construction, furniture manufacturers, mills, and clothing. Through the development of new technologies and markets, substances that we currently think of as waste become inputs for new products. A growing demand for these products is translating directly into new, well paying jobs for the region. A study by the United States Environmental Protection Agency (2001) indicates that the wages earned in the reuse and recycling industry are equally competitive with other major manufacturing jobs in the U.S. The average manufacturing wage for Oregon in 2000 was $45,839, compared to the average wage of $33,776.

As an example, St. Vincent De Paul of Lane County (SVDP) re-manufactures appliances, mattresses, furniture, clothing, and most recently, glass, at the Aurora Glass Foundry. SVDP employs 255 people per year, contributing 5 million dollars in annual payroll, of which 75% is directly attributed to recycled products.

Making the expansion of waste-based economic development a priority in Eugene and Lane County could generate new jobs while also reducing the city's greenhouse gas emissions.

Table 9: U.S. Recycling and Reuse Manufacturing Industries, 2001

	Recycling Manufacturing	Reuse and Remanufacturing
Firms	8,047	26,716
Number Employed	759,746	169,183
Annual Payroll	$ 29,181,749,000	$2,747,496,000
Revenues	$ 178,390,423,000	$ 14,182,531,000

Source: ECONorthwest using data from the Environmental Protection Agency, 2003

Sustainable and Organic Food Industries

The US Department of Agriculture and regional farmers indicate that using proper conservation tillage methods and applying integrated pest management techniques often result in net savings for the farm and reduced CO2. Besides increasing farmers' earnings, these practices have substantial environmental benefits, ensure future productivity of land resources, and provide production inputs to organic food processors.

The organic and sustainable foods industries are growing at above 20% annually in the Northwest and nationally and are the fastest growing sectors of the food trade. Organic farming means that no synthetic toxic pesticides or fertilizers are used. Sustainable farming generally includes but goes beyond organic to ensure that sustainable practices are employed in every aspect of the system, such as in land management, packaging, and transportation.

As concerns about pesticides and issues such as Mad Cow disease grow, the natural foods industry is certain to benefit. This sector already represents a significant economic contributor to the Northwest. Making the growth of these industries a priority for Eugene and Lane County would generate new jobs while also reducing the city's greenhouse gas emissions. For more information about this industry see the 2003 UO Resource Innovations (formerly Program for Watershed and Community Health) report on the natural foods sector in Lane County, Oregon.

Sustainable Forestry

Forestry has historically been a vital part of Oregon's economy. However, for numerous reasons, many communities that were once reliant on forest products for their livelihood have seen a loss of jobs and incomes related to the industry. One emerging solution to this problem is sustainable forestry. Sustainable forestry involves the adoption of environmentally sound forest management and harvesting practices, certification of these practices, and marketing and sales of the certified products to consumers. Sustainable forestry can maintain and create jobs while also increasing the number of trees and protecting basic ecological functions needed for carbon sequestration.

Certification allows consumers to have a non-biased independent party evaluate a company's practices to guarantee that it was done so in a sustainable manner. In 2003, there were 462 certified forests (465 companies) in 55 countries covering 78,188,459 total acres. The United States has a total of 9,460,755 acres, including 94 companies that are certified. Oregon has 12 certified forests (12 companies) covering 124,580 total acres.

Making the growth of the sustainable forestry a priority for Eugene and Lane County would generate new jobs while also enhancing carbon sequestration efforts.

Resident Priority #2 - Good Value for Tax Dollar

Eugene residents were asked to rate 17 community outcomes for importance and how well the community is doing at achieving outcomes. All of the outcomes were rated on a five-point scale. Ratings closer to five indicate higher levels of importance or performance evaluations closer to excellent, with lower numbers indicating lower importance or performance ratings. At the top of the list of importance at 4.6 is proving good value for tax dollars spent while performance level was listed at 3.2. The City of Eugene could increase its efficiency and also possibly generate cost savings in some areas through the adoption of greenhouse gas emission reduction plans.

For example, Denver, Colorado's Green Fleets policy, expects all city agencies which own/operate municipal fleets to decrease fuel expenditures by an average of 1% per year (adjusted for fuel cost inflation), and decrease CO2 emissions by 1.5% per year. The estimated effects of Denver's Green Fleets program by the year 2005, are annual fuel cost savings of $106,000 and a reduction in CO2 emissions of 22% relative to 1992 levels, even though the number of vehicle miles traveled will have increased by 19%.

Resident Priority #3 - Minimizing Loss of Life and Property from Emergencies

Another top priority for Eugene residents is minimizing loss of life and property from emergencies. This issue was given an importance of 4.5 and a performance level of 4.3. The development of adaptation plans aimed at minimizing loss of life and damage to private property and public infrastructure from natural hazards and emergencies caused by global warming and abrupt climate change (i.e. intense floods, drought, wildfires, increased public health problems, etc.) will demonstrate to residents that the city has done what it can to prepare for these events.

Average damage due to flooding in Oregon and Washington over the past twenty years is $259 million dollars (2002 dollars) (Goodstein and Matson). Using this estimation, a modest 10 percent average increase in flooding by 2040 from climate change, could increase potential flooding costs by $26 million. Thus, the development of strategies to prepare for the possibility of climate change related increased winter flooding might save property, infrastructure, and tax dollars while demonstrating the city's commitment to a leadership role on this issue.

Resident Priority #4 - Environmental Protection, Open Space, Parks etc.

More than half (53%) of the residents surveyed said they believe it is very important for the City to engage in environmentally sustainable practices, while only 9% feel the City is doing an "excellent" job of employing such practices. The importance of the City engaging in sustainable practices has a mean rating of 4.2 compared to a performance rating of 3.4.

Developing a climate protection plan that includes reducing greenhouse gas emissions in addition to protecting and restoring streams, wetlands, forests, and native plants and establishing or expanding carbon sequestration programs will help demonstrate to citizens the city's commitment and leadership to environmentally sustainable practices while also helping the community prepare for the potential consequences of climate changes such as winter flooding and summer draughts.

Resident Priority #5 - Compact Urban Growth

Residents participating in the survey gave compact urban development a ranking of 3.5 in terms of importance, and exceeded it in performance (3.7). Adopting mechanisms to limit sprawl and thus work towards more compact urban growth patterns will reinforce the city's leadership role on this issue while also creating more "walkable" spaces that decrease dependence on automobiles and thus reduce CO_2 emissions.

Resident Priority #6 - Climate/Weather

Residents of Eugene said that the city's mild temperatures and weather make it a desirable place to live. Global warming and abrupt climate change may significantly alter "traditional" weather patterns generating greater variations in climatic conditions including hotter summers and colder dryer winters and/or more intense rains and flooding in mid-winter months. Taking action to reduce the city's contributions to human-induced climate change by reducing GHG emissions and developing appropriate adaptation plans will demonstrate to citizens that the city is doing what it can to protect the climatic conditions people value.

Greenhouse Gas Emission Reduction Options for Local Government Operations

A variety of technologies and practices are available to local governments to reduce greenhouse gas emissions (GHG). The primary focus areas include lighting, buildings, procurement, water and wastewater, waste, fleets, and energy types and efficiency. This section outlines an array of options that can aid the City of Eugene, City of Springfield, and Lane County in their efforts to plan for global warming and abrupt climate change.

Energy Efficiency

The cheapest and best way to reduce greenhouse gasses is through increased energy efficiency. Employing energy efficient measures can range from replacing existing technology with more efficient technology or encouraging the use of renewable sources of energy, such as wind, solar, and hydroelectricity. It can also include making policy changes to reward conservation strategies.

Energy Efficient Light Fixtures

Replacing incandescent traffic signals with light emitting diodes (LEDs) consume less energy, have a longer life, and require less maintenance. Public, commercial, and retail buildings as well as individual homes can also replace inefficient lights with more efficient ones.

Fort Collins, Colorado

In 1997, the City conducted a pilot test of red LEDs and "Don't Walk" signs. The results indicated that LEDs would save $1.46/signal/day in electrical costs. Generally, LEDs pay for themselves in three to four years, and have a life span of seven to ten years. As of 1999, the City had already installed 28 intersections. If the City installs all new traffic signals using LED reds and Don't Walks (an estimated four new intersections per year), and retrofit all existing intersections, it would cost the city $286,000 for the retrofits, and $8,500/year for the new installation, but the City would save a cumulative $992,650 by 2010. It will also reduce Nitrogen oxide emissions by 0.3 metric tons/year, and sulfur oxide emissions by 0.4 metric tons/year.

Source: Fort Collins. "Measures to Reduce Greenhouse Gases from Energy Use." http://fcgov.com/airquality/pdf/ch6-energy.pdf

Occupancy Sensors

Occupancy sensors reduce energy waste by taking over light-switch chores. Sensors turn the lights on when they sense someone coming into a room or area, and then turn the lights off some time after sensing the room is empty. These sensors are best suited in spaces that are used infrequently or unpredictably, such as conference rooms, private offices, classrooms, storage areas, and bathrooms. Sensors can be mounted on the wall just like a light switch or installed in the ceiling.

Green Pricing Programs

Some power companies are now providing an optional service, called green pricing, that allows customers to pay a small premium in exchange for electricity generated from clean, renewable ("green") energy sources. The premium covers the increased costs incurred by the power provider (i.e. electric utility) when adding renewable energy to its power generation mix, whether it be natural gas, hydropower, wind, or geothermal energy. Any buildings receiving electricity from a provider that offers green pricing can participate in the program.

Ashland, Oregon

In November 2003, the City of Ashland, Oregon and the nonprofit Bonneville Environmental Foundation (BEF) teamed to offer the city's electricity customers a new green power option. Under the Renewable Pioneers program, residents and businesses can support local and regional renewable energy development by purchasing Green Tags directly from BEF at a cost of 2¢/kWh. Ten percent of the revenues from green tags sales to Ashland residents and businesses will be used to fund solar projects within the city. Program participants will see no change in their utility bills because the green tags purchase is a separate transaction with BEF.

Source: U.S. Department of Energy. Energy Efficiency and Renewable Energy: Green Power. "Green Pricing." 2004. http://www.eere.energy.gov/greenpower/markets/pricing.shtml

Energy Rebates and Low Interest Loans

Many utilities, including EWEB, SUB, and Lane Electric provide incentives such as rebates or low interest loans to encourage businesses, residents, and industry to be more efficient in their use of energy. The rebates and loans usually apply to new windows, appliances, solar hot water, and the installation of renewable energy systems.

Sacramento Municipal Utility District (SMUD), California

SMUD is a publicly owned municipal utility which provides electricity to over a million people living in an area of 900 square miles in the City of Sacramento, California, and the surrounding area. SMUD's Conservation Power Financing Program (PFP), started in 1990, provides loans and rebates for a range of electrical efficiency measures to the utility's residential, commercial, industrial, and agricultural customers. A separate program applies to public schools, local governments, and other public agencies.

Through the PFP, SMUD provides free audits, identifies appropriate energy efficiency measures, identifies financing options, helps arrange installation of the retrofit measures by an outside contractor, and provides ongoing monitoring. The utility also provides rebates for the installation of certain peak energy saving measures, including: indoor and outdoor lighting conversions ($150 per kW saved or controlled); cooling/refrigeration/electric heating modifications or replacements ($250 per kW saved or controlled); demand limiting devices and energy management systems ($50 per kW shed or controlled); and daylighting systems ($250 per kW controlled). Source: ICLEI. "Conservation Power Financing Program (PFP)." 1995-2005. http://www.iclei.org/cases/c013-smu.htm

Public Facilities

Optimize Waste Distribution and Wastewater Treatment Systems

Water distribution is often the largest single component of energy use by local governments. Across the United States, energy consumption accounts for 50 to 75% of the costs of operating municipal water systems. Of this, water pumping often consumes 80% or more of the electricity used in water distribution and treatment. Many cities are using Supervisory Control and Data Acquisition (SCADA) systems to slash their energy costs. SCADA is a category of software application program for process control, the gathering of data in from remote locations in order to control equipment and conditions. SCADA is used in power plants as well as in oil and gas refining, telecommunications, transportation, and water and waste control.

Building Design & Efficiency

Green Building and the LEED Rating System

Improving building design and efficiency is often termed "green building". Green building techniques strive to design and operate buildings to use energy more efficiently. Consequently, most green buildings use renewable sources of energy (i.e. solar, wind, and biomass) and are built from materials that have a reduced effect on the environment throughout their life cycle (i.e. recycled content, low toxicity, energy efficiency, biodegradability, and/or durability). Green building techniques can be used in any new or existing building, including residential dwellings and businesses.

The LEED (Leadership in Energy and Environmental Design) Green Building Rating System® is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. Members of the U.S. Green Building Council representing all segments of the building industry developed LEED and continue to contribute to its evolution. LEED provides a complete framework for assessing building performance and meeting sustainability goals. Based on well-founded scientific standards, LEED emphasizes state of the art strategies for sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. LEED recognizes achievements and promotes expertise in green building through a comprehensive system offering project certification, professional accreditation, training and practical resources.

For more information about the LEED rating system see the U.S. Green Building Council website: *http://www.usgbc.org/leed/leed_main.asp*

For information about green building efforts in Lane County see:
http://cwch.uoregon.edu/ReportsFolder/Lane_County_Final_Green_Building_Report10_10_2003.PDF

Lillis Business Complex – University of Oregon - Eugene, Oregon

The new home of the Lundquist College of Business, the 133,000 sq. ft. four-story building was designed to meet LEED (Leadership in Energy and Environmental Design) Silver certification and features many sustainable design elements such as perimeter daylighting, recycled building materials and energy-efficient mechanical systems. The most prominent sustainable component of the project employs photovoltaic cells inlaid in the building's four-story glass entryway. Designed to harness energy from the sun, these cells generate electricity used to power the building. The Lillis Business Complex is 50% more energy-efficient than state code requires. (Source: University of Oregon. "Lillis Business Complex." http://libweb.uoregon.edu/guides/architecture/oregon/lillis.html)

Balfour Guthrie Building – Portland, Oregon

The Balfour Guthrie Building is historic in nature and progressive in performance. Originally constructed in 1913, the stone structure has hosted a variety of tenants who have configured and used the space in a number of ways. Where once stood a production machine, however, now stands a daylight design station. The Balfour Guthrie Building's most recent tenant, Thomas Hacker Architects, Inc., redesigned the building and balanced objectives for historic preservation and sustainability by including such features as a high-efficiency heating and cooling system, exposed structural elements, and an integrated day-lighting strategy among others. The design has renewed the historic integrity of the building while enhancing its performance 24% beyond energy code. (Source: Portland's Greenbuilding Resource. "Commercial Building Case Studies." http://www.green-rated.org/cs_list.asp?md=commercial)

Seattle, Washington

EPA Region 10 used environmentally responsible design and construction as a pollution prevention measure in the renovation of 8,000 square feet of office space in its Seattle Regional Office. The Region demonstrated approaches in space planning and small tenant improvements that allow significant flexibility, encourage the creation of smaller offices, and reuse as many materials as possible. The project aimed to minimize the consumption of natural, financial, and infrastructure resources, to limit the office's contribution to the waste stream and to safeguard the health of other tenants occupying the floor during construction.

Reused materials including doors and door jams, relights, ceiling tiles, sconces, chair rails, cabinets, insulation, and door hardware. Reusing materials has enabled the City to save 12% of their project budget equating to at least $16,000. Some of the other techniques the City used was: (1) Maximized day lighting by limiting the number of offices on the perimeter; (2) Focused on creating open work areas with storage, copy room, and conference spaces in interior core space (3) Installed glass relights beside office doors (4) Installed occupancy sensors in enclosed offices; and (5) Utilized high-energy efficient parabolic lenses and fluorescent lighting. (Source: U.S. Environmental Protection Agency. "Green Building." 15 December 2004. http://www.epa.gov/oaintrnt/facilities/seattle.htm)

Computerized Climate Control Systems

A networked control system orchestrates the building's heating, cooling and fresh air ventilation systems. The system is programmed to provide the best comfort at the lowest energy consumption. The ventilation system provides fresh air to all the office working spaces, while removing stale air at the same time to provide superior indoor air quality. Carbon dioxide sensors in open spaces provide information for the computerized control system to automatically adjust the amount of fresh air delivered based on activity in the building. This saves energy by ventilating only when it is needed and improves air quality by ensuring that fresh air needs are always met. These systems are commonly used among large buildings by the government and wider community.

Passive Solar Design

Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. In this approach, the building itself or some element of it takes advantage of natural energy characteristics in materials and air created by exposure to the sun. Buildings designed for passive solar and daylighting incorporate design features such as large south-facing windows and building materials that absorb and slowly release the sun's heat. Passive systems are simple, have few moving parts, and require minimal maintenance and require no mechanical systems. Passive solar design techniques can be used in any new or existing building, including residential dwellings and businesses.

Caspar Point, Northern California

The 3,000-square-foot Caspar Point home is located in northern California on a rugged point of land jutting out into the Pacific. It incorporates southern exposure, sun spaces, thermal mass, insulating envelope, earth coupling, and thermosiphon solar-heated water for domestic hot water and radiant floors. The solar heating strategies have maintained comfortable indoor temperatures in an extremely harsh climate without the use of fuel since the home was completed in 1991.

Source: Heckeroth, Steven. "Solar Building Design." Backwoods Home Magazine. http://www.backwoodshome.com/articles/heckeroth63.html

Solar Hot Water

Solar hot water heaters use the sun to heat either water or a heat-transfer fluid in collectors. There are passive systems and active systems. A typical system will reduce the need for conventional water heating by about two-thirds. Sometimes the plumbing from a solar heater connects to a building's existing water heater, which stays inactive as long as the water coming in is hot or hotter than the temperature setting on the indoor water heater. When it falls below this temperature, the building's water heater can kick in to make up the difference. High-temperature solar water heaters can provide energy-efficient hot water and hot water heat for large commercial and industrial facilities. Like green building, and passive solar heating, this energy efficient technique can also be employed in residential buildings. Some residences utilize this form of renewable energy to heat swimming pools.

Sunoco Car Wash - Markham Ontario, Canada
This carwash preheats its water using forty solar collectors. Car washes using conventional boilers fired by natural gas, generate greenhouse gas emissions, particularly carbon dioxide. The solar car wash will save an estimated 16,000 cubic meters of natural gas and reduce carbon dioxide emissions by 30 metric tons each year at this particular service center.

Source: ARISE Technologies Corporation. "Success Stories." http://www.arisetech.com/Solar_Info/Success_Stories.html

Photovoltaic Systems

Photovoltaic systems use sunlight to power ordinary electrical equipment, for example, household appliances, computers and lighting. The photovoltaic (PV) process converts free solar energy - the most abundant energy source on the planet - directly into electricity. The use of solar systems is booming across the Northwest and nationally. They are being used to power industrial and retail facilities, public buildings, hospitals, recreational sites and parks, and households.

Heat Recovery Ventilators (HRV)

HRVs uses outgoing air to heat a package of aluminum plates, which then warm up incoming air. With no rotating parts to wear out, maintenance time and cost plummet. There systems are commonly used among large buildings by the government and wider community.

University of Ottawa, Canada, HRV System

Because the incoming air doesn't need to be heated as much before it enters the building, the University saves money on its heating bills. After the installation of the air-to-air units, total energy use at the university dropped by about two million equivalent kilowatt hours, for a cash savings of $62,000 a year. Those savings, together with a provincial incentive, mean each new unit installed pays for itself in an average of three years.

Not surprisingly planners at the University now discuss installing heat recovery equipment in all new construction and renovation projects. The new system fits into an overall effort by the university to use energy wisely. It has also installed a campus-wide computer-based monitoring and control system, new insulation in roofs and walls, new windows, T-8 lighting conversion, and projects to manage peak demand and water efficiency. Overall, the university has saved $3 million per year from its energy efficiency efforts.

Source: Natural Resources Canada. 20 October 2004. "Meeting Climate Change Challenges Through Energy Efficiency". http://oee.nrcan.gc.ca/publications/infosource/pub/ici/eii/M27-01-1035E.cfm

Low-Income Residential Energy Efficiency Programs

Energy efficiency programs encourage cities to form partnerships with other agencies to help families afford low-income housing by reducing energy costs.

Vermont
Vermont's Residential Energy Efficiency Program (REEP) works with property developers, owners, and managers to reduce energy costs and promote long-term affordability of low-income housing. The program was established in 1997 to overcome technical, financial, and regulatory barriers to improving the energy performance in Vermont's low-income multifamily housing. This unique partnership between local utilities and the low-income Weatherization Assistance Program (WAP) leverages utility incentives, WAP subsidies, and owner investments to implement all cost-effective energy measures. In less than two years, REEP has put over $1,275,000 in energy improvements in 893 low-income multifamily residential units throughout Vermont. REEP accomplished this with less than $400,000 in incentives from local utilities and the WAP. Estimated annual customer energy savings are over $255,000 annually. Vermont's program has been able to reduce CO2 emissions by 945 metric metric tons per year.

(Source: U.S. Environmental Protection Agency. "Residential Energy Efficiency Program for Low-Income Multifamily Housing."
http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/RAMR5CYQWT/$File/VT_REEP.pdf

Transportation: Reduce Vehicle Miles Traveled (VMT)

The goal of encouraging the use of public transportation is to minimize the use of single passenger vehicles that contribute to congestion and pollution. In addition to the examples listed below, other ways to reduce VMT are to expand public transit routes and hours, accommodate bikes on buses, offer free bus passes to City employees, allow youth and elderly to ride the bus for free, expand bike path network, create bike loaner programs, and use bikes as a source of transportation in City Departments (i.e. police). The following examples are just a few of the ways local governments can reduce VMT in their jurisdiction and surrounding community.

Telecommuting

Telecommuting allows employees to fulfill their job duties at home without having to drive to work. This saves employers time by not having to drive to and from work as well as reduces greenhouse gas emissions.

Portland, Oregon

The Green Team in Portland created a "Car Free and Care Free" (CFCF) week sponsored by the Westside Transportation Alliance. CFCF encourages employees to get out of their cars by telecommuting or using an alternative form of transportation, such as light rail, bus, bike, carpools, or walking. Over 100 City employees participated in the first CFCF in 1999; they reduced emissions of the greenhouse gas CO2 by 4 metric tons. In 2000, the Green Team partnered with the City's Transportation Options Division to add an open house to the event. Organizers provided information about transportation alternatives, promoted Bike Month, and held bike rides.

(Source: Green Team. "Sustainable Portland." Energy Division.
http://www.sustainableportland.org/energy_gov_green.html)

Employer Trip Reduction Programs

Trip reduction programs offer incentives to employees to encourage them to use alternative forms of transportation to and from work. Those who honor the program are rewarded, and those who don't have to pay the price. This approach not only improves availability of parking on site, but also reduces congestion in the city. These programs can be used by local governments in their own operations as well as by businesses throughout the community.

Bellevue, Washington

Bellevue, Washington's Trip Reduction Program is one of the most successful in the country. The high participation rates are largely achieved by charging $35 per month to park and making those funds available for other Transportation Reduction Program incentives. The total annual program budget is $125,000 with parking revenues generating approximately $100,000 of that total.

The program affects the City's three main work sites. All employees who arrive at work using an alternate commute mode for at least 60% of their commute trips receive free parking on the days they drive. Employees who walk, bicycle or carpool at least 80% of their commute trips receive a financial incentive of $15 per month. Employees who take the bus for 80% of their trips receive a subsidy of $39.50, equivalent to the cost of a monthly transit pass.

Bellevue employees have access to vanpools run by METRO, the regional transit agency. The price the employee pays for the vanpool service is offset by a $39.50 per month subsidy which the City of Bellevue pays to METRO.

For carpoolers, Bellevue also has an innovative "Fleetride" program. The employee who is the designated carpool driver is allowed to use one of Bellevue's fleet cars for their commute trips. Fleetride cars are returned to the fleet pool each day. There must be at least three city employees participating in the carpool to be eligible for the Fleetride program. Direct emissions reductions through this program exceed 40,000 metric tons of CO_2, 250 metric tons of NO_x, and 300 metric tons of volatile organic compounds per year.

(Source: ICLEI. Trip Reduction Program. 1995-2001. http://www.iclei.org/cases/c003-trp.htm; Pew Center on Global Climate Change. "State and Local Net Greenhouse Gas Emissions Reduction Programs." http://www.pewclimate.org/states.cfm?ID=14)

Huntington Beach, California

The City of Huntington Beach's Transportation Reduction Program is titled "Alternate Commute Program". Huntington Beach's program is unusual in that it offers credits to alternate mode commuters that can be exchanged for work time off, or converted to gift certificates from local vendors. The number of credits received depends on how much air pollution is avoided by the participant's choice of commute mode.

(Source: ICLEI. "Alternate Commute Program." 1995-2004. http://www.iclei.org/cases/c005-acp.htm)

Rideshare Programs

These programs offer carpooling and other environmentally responsible transportation options to a variety of cities nationwide. A website is generally the medium used to enable commuters to get in contact with other commuters. Through the website they can learn about the time and location of their travels and get in contact with them if they wish to carpool with that person. This carpooling option reduces the number of people on the roads, and thus congestion and air pollution. These programs can be used by local governments in their commuter programs as well as by the wider community.

Oregon

There are a variety of carpooling options in Oregon. One is offered by the City of Portland and is known as Car Pool Match Northwest (www.carpoolmatchnw.org). The service is primarily designed to curtail the emission of 70,000 metric metric tons of carbon dioxide over a ten-year period by decreasing single occupancy vehicle commute trips. Another program in Portland is referred to as eRideShare (www.erideshare.com). This particular website has a variety of locations throughout the United States with people trying to get in contact with others to carpool. There is also a Mid-Willamette Valley Rideshare program (http://www.cityofsalem.net/%7Erideshar) based out of Salem, Oregon that allows you to locate carpoolers, vanpools, walkers, bikers, or other persons using environmentally responsible forms of transportation. This particular service requires that you fill out an application form, and upon receiving your application you will be sent a list of potential matches with contact information.

High Occupancy Vehicle Lanes

High occupancy vehicle lanes, or carpool lanes, encourage people driving during peak hours (i.e. rush hour commute) to carry two or more passengers in their vehicle. Major thoroughfares are typically congested during peak hours, because most people drive alone to and from work. Those persons traveling with two or more persons are able to pass these vehicles that are traveling in adjacent lanes. Buses, vanpools, and vehicles carrying two or more persons are permitted to use the High Occupancy Vehicle lanes. Local governments and the state department of transportation have the authority to create high occupancy vehicle lanes. While the general community doesn't have the opportunity to create such lanes, they can share in the benefits if and when they are created.

Boston, Massachusetts

The Southeast Expressway (I-93) is a principal eight-lane highway linking Boston and communities to the southeast of the city. As the second most heavily traveled highway in New England, the Expressway accommodates 200,000 vehicles each weekday. Reports indicate 10 to 15 minute travel time savings per commute for 3-plus carpoolers, vanpoolers and public transit riders. Currently, 2600 vehicles carrying 18,000 people are using the lane, up from 2000 vehicles carrying 13,000 people in December 1995. Non-HOV lane users noticed an improvement in traffic conditions as the Express Lane boosted capacity and moved traffic more efficiently.

Boston, Massachusetts (continued)
The environment also benefited from the decrease in pollutants, as the HOV lane transports greater numbers of commuters in fewer vehicles. Over the 20 year life-cycle of improvements made to this expressway, it is anticipated that the city will witness a 60 percent decrease in smog-causing volatile organic compounds, and a 92 percent decrease in CO_2 emissions that would have otherwise occurred at this site without the improvements

(Source: Barrier Systems Inc. “Success Stories.” 2003. (http://www.highways.org/pdfs/unclog.pdf).

Land Use Related Measures (Smart Growth)

Land use measures can reduce greenhouse gas emissions through what is often called Smart Growth. Smart Growth places affordable apartments and houses within walking distance of offices, stores, and entertainment. It also pays attention to details like front porches, wide sidewalks, and community parks that encourage people to gather with their neighbors. Smart Growth’s intent is to plan development around public transit, so people can spend less time in their cars. And whenever possible, development is focused in already existing communities, so that outlying farmland and open space remain protected. Smart growth can be accomplished through new zoning and development regulations that promote higher density and transit; site design standards; public facilities policies; and street construction standards that accommodate bikes and pedestrians. In order for these to occur, a transportation impact study should be required for new developments and there should be intergovernmental agreements and sub-area plans to illustrate and fulfill the efficient land use guidelines.

Land use planning which promotes compact development without the typical sprawl of recent automobile-dependent suburbs is one way that cities can reduce the number of miles inhabitants must travel. Public transit is more economical and convenient in areas with higher population densities, but if municipalities are zoned to permit mixed residential and commercial uses, it is much more likely that people can walk or cycle to work or to shop. Comparisons of cities around the world show a clear link between urban population density and gasoline consumption.

Mountain View, California

One of the worst side effects of sprawl is the time people spend driving their cars. In the last three decades, total vehicle use has more than tripled nationwide as people are forced to drive to work, the grocery store, or the movies. California's booming Silicon Valley is infamous for time spent behind the wheel, but the town of Mountain View decided to make a change. Working with an architect who understood what the community needed, the city and a builder named TPG Development launched The Crossings, a cluster of 300 homes built around a new commuter train station and located within walking distance of shops, offices, and open space.

The Crossings incorporates two smart-growth elements that free people from their cars: access to public transportation and high-density design. The typical suburban formula of one house per acre stretches the outer limits of towns and adds to residents' commuting time. In contrast, The Crossings has 22 units per acre. Thanks to careful planning, residents say this density does not feel confining, because it is so easy for them to walk to shops, nearby offices, or the train station. They note that the parks, wide sidewalks, lush landscaping, parks, and pleasant streets create a feeling of spaciousness. In fact, despite claims that consumers dislike density, the Center for Livable Communities reports that The Crossings has some of the fastest selling homes in the region.

Source: Natural Resource Defense Council. “How Smart Growth Solves Sprawl” http://www.nrdc.org/cities/smartGrowth/solslide/solslide4.asp

Computerized Routing Systems

Electronic navigation works by providing drivers with a computerized road map showing congestion ahead and flashing suggested alternate routes around the trouble. It is one part of a broader area of research and development collectively called Intelligent Vehicle Highway Systems (IVHS), or commonly known as "smart cars/smart highways". In doing so, it can help employees and the wider community get to a destination more quickly, and avoid heavily congested areas that require extended period of idling, and stop and go traffic.

<u>Transportation: Maximize Fuel Efficiency</u>

In many cases, City staff is unable to utilize public transportation to fulfill their job duties. It makes sense that if employees have to drive, the vehicles they use should be cost effective and pollute as little as possible. The following is a list of ways municipal fleets can maximize their fuel efficiency. These programs can extend to individuals outside of the local government in their own personal vehicle preferences.

Phase-Out Inefficient Vehicles

Programs with an emphasis on maximizing fuel efficiency strive to replace old vehicles with newer, more compact ones that meet specified fuel efficiency standards. This might include incorporating vehicles into the fleet that operate on alternative sources of fuel, such as hydrogen, electricity, or biodiesel. Performing frequent vehicle maintenance, requiring driver education and training, and creating policies on idling restrictions can also help reduce greenhouse gas emissions and save money.

Denver, Colorado

The City of Denver's Green Fleets Program, enacted on April 22, 1993, contains a broad range of programs and policies to maximize the fuel efficiency of its municipal fleet. Denver's Green Fleets Executive Order mandates a reduction in the number of fleet vehicles, a reduction in vehicle miles traveled, and a preference for the purchase of fuel-efficient vehicles. Vehicles targeted are any vehicles in the fleet that operate on gasoline or an alternative fuel, and are rated at one ton or under. When new or replacement vehicles are requested, fleet managers and department heads are asked to evaluate the vehicle's intended use and downsize it to the smallest possible vehicle which could still complete the required function.

Another key feature of Denver's vehicle purchasing policy is the inclusion of miles per gallon targets in their new vehicle bid specifications. Specifying the miles per gallon target is important to ensure that vehicles purchased have the fuel efficiency desired. Other areas that are addressed by the Green Fleets policy are idling restrictions, driver education and training, and vehicle maintenance.

Through this Green Fleets policy, all City agencies which own/operate municipal fleets shall decrease fuel expenditures by an average of 1% per year (adjusted for fuel cost inflation), and decrease CO_2 emissions by 1.5% per year. The base year for determining fuel and emission reductions is 1992. The estimated effects of Denver's Green Fleets program by the year 2005, are annual fuel cost savings of $106,000 and a reduction in CO_2 emissions of 22% relative to 1992 levels, even though the number of vehicle miles traveled will have increased by 19%.
(Source: ICLEI. "Green Fleets Program." 1995-2005. http://www.iclei.org/cases/c002-dgf.htm)

Alternative Sources of Fuels

Alternative sources of fuel can be derived from natural gas, electricity, ethanol, propane, and biodiesel. Although natural gas is a fossil fuel it is the one fossil fuel that is actually quite clean. Ethanol (E85) is a mixture of 85% ethanol (a fuel derived from the fermentation of cereal) and 15% gasoline. Vehicles that run on electricity require "charging stations" to re-charge their vehicles battery. Another option is to purchase hybrid vehicles that run on both gasoline and electricity; the vehicle charges itself as you drive. Biodiesel is a combination of ethanol and waste or pure vegetable oil. All of these fuel types have the potential to improve air quality by reducing greenhouse gas emissions.

A company called Sequential BioFuels is selling the biofuels throughout Oregon, with a primary focus on fleets. In addition, legislation has been introduced to the 2005 state legislature aimed at supporting the development of the biofuels industry.

University of Oregon – Eugene, Oregon
Two tractors used by the campus and grounds maintenance team on the University of Oregon's Campus burn 100% bio-diesel fuel. All other diesel powered equipment and vehicles use a 20% mixture of bio and regular diesel fuel.

Source: University of Oregon. "Mobile Equipment Shop." 2003.
http://facilities.uoregon.edu/mobile.php

New York City, New York

The Alternative Fuels Program is working to replace New York City's public fleets with alternative fuel vehicles in order to promote and expand usage of alternative fuels, which are much less polluting to the air and more friendly to the environment. This effort began in 1993 with the conversion of 385 New York City municipal fleet vehicles to compressed natural gas (the New York City Fire Department prohibits use of any other type of natural gas in the city). Since that time, the Alternative Fuels Program has expanded its range of involvement and works closely with all levels of government agencies operating fleets in New York City. Close relationships have also been developed with utilities (KeySpan and Con Edison) and a few private sector fleets. As a result, the number of alternative fuel vehicles on New York City roads now totals over 6,000. These vehicles are a mixture of natural gas, hybrid, E85 (ethanol), and electric vehicles. New York City operates one of the largest municipal electric vehicle (EV) fleets in the United States with over 70 EVs in use.

The main alternative fuel choice in New York City, at present, is compressed natural gas (CNG). Although natural gas is a fossil fuel it is, as mentioned before, the one fossil fuel that is actually quite clean. CNG emits less nitrogen oxide (NOx) and particulate matter (PM) than gasoline. Natural gas buses have been proven to produce an average of 97% less particulate matter (PM), 84% less carbon monoxide (CO) and 58% less nitrogen oxide (NOx).

Source: New York City Department of Transportation. "DOT Alternative Fuels Program." http://www.nyc.gov/html/dot/html/motorist/alternativefuel.html

Fort Collins, Colorado

The City of Fort Collins Fleets Services has demonstrated a longtime commitment to alternative fuel vehicles. As an example, in 1997, 152 (34%) of the City's fleet of 450 vehicles were powered by propane. In 1998, the municipal fleet consumed 166,245 gallons of propane fuel. This translates to 139 metric tons of CO_2 eliminated in 1998 through the use of propane fuel.

Source: Fort Collins. "Colorado Existing Emission Reduction Measures." http://fcgov.com/airquality/pdf/ch3-exist.pdf

Seattle, Washington

Under the new "Clean Green Fleet Action Plan," approximately half of all compact cars purchased by the city will use cleaner-burning alternative fuel such as compressed natural gas or get at least 45 miles per gallon. In 2000, hybrid electric cars were added to the fleet because they are 60% more fuel efficient than the standard car. Today, the City has more than 200 clean and green vehicles in the fleet. In 2001, the entire diesel fleet was converted to cleaner ultra-low sulfur diesel. And work started on retrofitting 400 of the City's heavy-duty trucks with emission control devices. These two measures cut toxics and particulates by about 50% per vehicle.

Source: Seattle's Office of Sustainability and Environment. "What are the air quality issues in Seattle in 2004?" 1995-2005. http://www.seattle.gov/environment/clean_air.htm#greenFleet

Truck Stop Electrification

The U.S. Department of Transportation (DOT) estimates that approximately 5,000 truck stops in the United States offer parking and other services, including fueling stations, restaurants, stores, and showers. Truck stops are vital to our transport system. Because DOT mandates that truckers rest for 10 hours after driving for 11 hours, truckers may park at truck stops for several hours. Often they idle their engines during this rest time to provide their sleeper compartments with air conditioning or heating, or to run electrical appliances such as refrigerators or televisions.

Truck stop electrification allows truckers to "plug in" vehicles to operate necessary systems without idling the engine. In some cases, a stand-alone system can provide heating, ventilation, and air conditioning directly to the sleeper compartment.

Options for truck stop electrification include stand-alone systems that are owned and operated by the truck stop, and combined systems that require both on-board and off-board equipment.

Argonne National Lab estimates that, based on the approximately 460,000 long-haul trucks currently operating in the United States, idle reduction technologies could reduce diesel fuel use by 838 million gallons/year. That wasted diesel fuel translates to $1.4 billion that could be saved by drivers using idle reduction technologies.

By reducing the amount of time that trucks idle, estimated at about six hours/day, drivers can significantly reduce engine wear and the associated maintenance costs. Routine maintenance can be performed less often and trucks can travel farther before needing an engine overhaul.

In addition, Argonne National Lab estimates that idle reduction technologies used by the approximately 460,000 heavy-duty trucks operating on diesel fuel can reduce emissions of NOx by 140,000 metric tons, CO by 2,400 metric tons, and CO2 by 140,000 metric tons per year.

For more information, visit the Department of Transportation Idle Reduction homepage at http://www.eere.energy.gov/cleancities/idle/.

Reduce Speed Limits

Because vehicles produce more carbon dioxide at high speeds, reducing speed limits can help reduce greenhouse gas emissions that lead to global warming.

Ecosystem Management: Carbon Sequestration

In addition to using energy more efficiently and encouraging the use of renewable sources of energy, another way to manage carbon is through carbon sequestration. This refers to the long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide (the principal greenhouse gas) concentration in the atmosphere will reduce or slow. Carbon sequestration can be accomplished by maintaining or enhancing natural processes (i.e. preserving wetlands or planting trees), or through more novel techniques (i.e. sequestering carbon in underground geologic repositories). For more information on carbon sequestration visit the U.S. Department of Energy at *http://cdiac2.esd.ornl.gov/.*

Forests

Planting trees aids in carbon sequestration, or the capture of carbon dioxide (CO_2) and other greenhouse gases that would otherwise be emitted to the atmosphere. Consequently, the more trees you plant, the more CO_2 will be absorbed and converted into oxygen. Carbon offsets are tradable permits that can be used to reduce greenhouse gas emissions. A forest-based carbon offset is a general term for a specific amount of greenhouse gas emissions reduced or sequestered by the protection or restoration of a forest ecosystem. Often expressed as metric tons of carbon (tC) or metric tons of carbon dioxide equivalent (tCO_2E), offsets can be traded in various markets or used to meet the reduction goals of a corporation or county.

In forest carbon offsets, investments in the conservation and management of forests are made by companies such as electric utilities in recognition of the forest's value as a carbon sink for offsetting carbon dioxide (CO_2) emissions, the predominant "greenhouse gas" that contributes to global warming.

Oregon

Forestry carbon offsets offer an innovative mechanism to stimulate the forestation of thousands of acres of underproducing forest-land. In 1999, Oregon's Forest Resource Trust received $1.5 million from the Klamath Cogeneration Project, a natural gas—fired electricity and steam generation plant, for the forestation of 2,400 acres of underproducing non-industrial private forests (NIPF). This forestation effort will accrue 1.16 million metric metric tons of carbon dioxide emission offsets over a 100-year period. To encourage landowners to turn their land into productive forests that sequester carbon, the trust pays the full costs of the forestation. Landowners can use their new forests for any purpose, including timber production, but give up any claim to the carbon offsets. The offsets are passed back to the Klamath project as part of its emission offset portfolio.

(Source: Cathcart, J.F. Carbon Sequestration: A Working Example in Oregon. Journal of Forestry. Vol. 98, no. 9. pp.32-37, Sept. 2000)

In 2001 the Oregon Legislative Assembly passed House Bill 2200 recognizing the beneficial role forested lands play in reducing atmospheric levels of CO_2 through carbon sequestration. HB 2200 created the opportunity for marketing carbon offsets from forest stand growth; the Forest Resource Trust (operated by the Oregon State Forester's Office) receives funds from non-profits that pass corporate funds to the government in exchange for carbon offsetting activities. At present the Forest Resource Trust establishes financing opportunities for landowners from funds provided via pollution creating industry (for example Portland General Electric, and PacifiCorp or in this case Lane County) looking for methods to deal with excess industry production of CO_2. Bill 2200 idealizes increasing state wide forested acres and improving overall air quality by making financing available to small-scale landowners to increase forested acreage. By using the CO_2 offsets created by planting new trees as a financial leverage to continued monies from industry Bill 2200 serves as a method of increasing forested acres, improving air quality, boosting the financial well being of landowners, and offsetting the production of CO_2 by industry (Forestry and Wood Products, 2005). The "Oregon Strategy for Greenhouse Gas Reduction" states the importance of sequestration as follows for Governor Kulongoski's recommendation for Carbon reduction in Oregon from 2004:

> Oregon's fields and forests are valued by Oregonians for economic, environmental and recreational reasons, but they can and must perform an additional service. The Advisory Group recommends actions to increase the amount of carbon that can be captured and fixed in new or restored forest and field growth and in the soil beneath. Decades of clearing forests, turning the soil, and building cities and highways where there had been undisturbed ground, have both released large quantities of greenhouse gases and impaired the land's physical ability to take up and sequester excess gases. While we will continue to work the lands that must feed, clothe and shelter us, there are still land management choices that will restore much of this natural sequestration capability. Reforestation and conservation reserves in lands of marginal economic value are familiar tools. These uses must be stepped up dramatically, encouraged and sustained with government policies and public investment dollars (Oregon Strategy for Greenhouse Gas Reductions, 2004).

As quoted from Jim Cathcart's article, "Forest, Climate and Global Climate Change" from the September, 2000 Journal of Forestry (Jim also works for the Oregon State Forestry Office and the Forest Resource trust):

> Forestry-based carbon offset programs involving family forest owners usually offer the landowner some sort of favorable financial assistance to cover the cost of site preparation, tree planting, seedling protection and competitive release in exchange for obtaining ownership of the carbon offsets arising from the newly created forest. A common denominator to these programs is the type of land they target-under producing land capable of supporting a forest, but currently lacking a manageable stand of trees or seedlings. Examples include old pastures, abandoned Christmas tree lands, wildfire-burned lands, brush fields, agricultural lands or otherwise productive lands dominated by non-commercial tree species. These are lands that will likely remain in a non-forested condition unless financial assistance to plant and establish trees on a particular site is provided. The need for financial assistance is important because carbon programs must create new forested land to claim credit for carbon offsets (Cathcart, 2000, p. 34).

The Forest Resource Trust creates a valid opportunity for Lane County to offset or mitigate existing CO2 production by simply planting trees (for more information on the Forest Resource Trust contact Jim Cathcart with the State Foresters Office). Whether in collaboration or on its own planting trees creates a great CO2 mitigating opportunity. The graph below highlights the reductions available from planting trees on previously non-forested areas (Cathcart, 2000, p. 34).

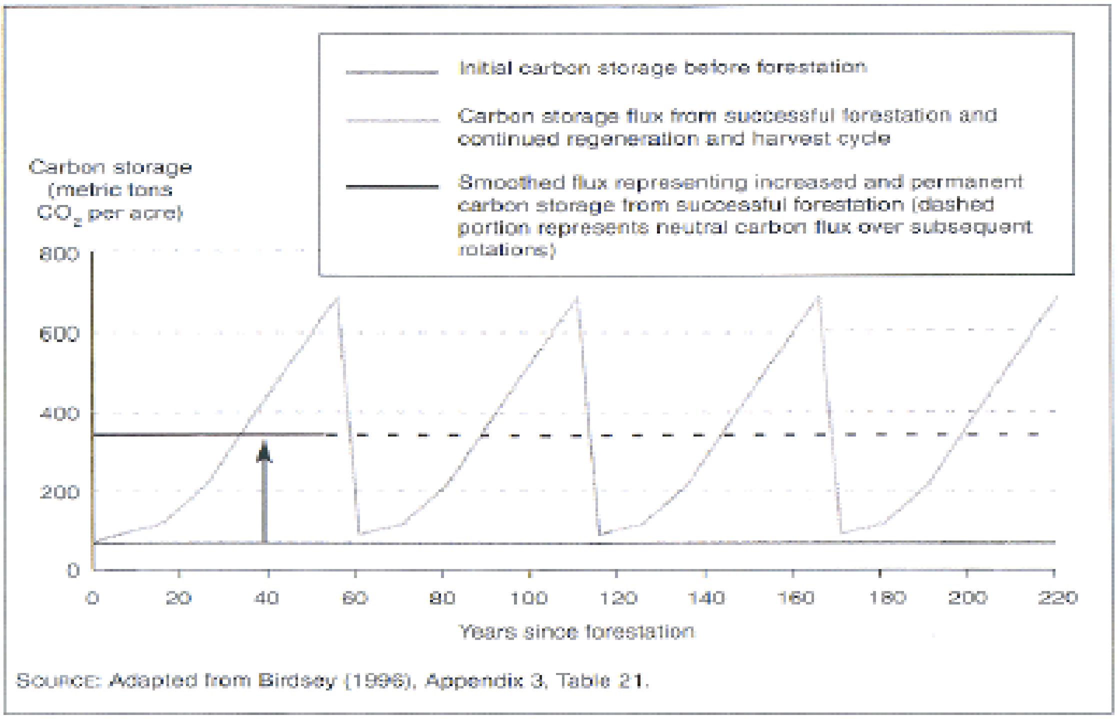


***Figure 1.* Permanent carbon storage from the forestation of underproducing lands managed for timber production over a perpetual even-aged harvest and reforestation cycle.**

Wetlands
Because wetlands are highly productive and accumulate large below-ground stocks of organic carbon, restoring lost wetlands and protecting those that remain represents an opportunity for enhancing terrestrial carbon sequestration. Carbon is stored in wetland sediments over the long term. Short-term stores are in existing biomass (plants, animals, bacteria, fungi) and dissolved components in the surface and groundwater. The magnitude of wetland carbon storage capacity are unknown. While some carbon cycling data are available on a small scale, it remains unknown whether these data represent all situations or can be extrapolated to the landscape level.

"When weighting the positive effects of carbon sequestration versus the production of small amounts of methane and nitrous oxide, wetland restoration must still be considered as one of the best ecosystem alternatives for mitigating atmospheric accumulation of CO2 if done on a large scale restoration, such as has been proposed for the Midwest USA. Restored wetlands could also have the added benefit of mitigating drought conditions caused by climate shifts and could assist in minimizing the effects of floods in areas with wetter climates" (Mitsch).

"Following the 1997 Kyoto Protocol, which provided for biological sinks as a measure to mitigate greenhouse gas emissions, the Wetlands International Association of State Wetlands Managers (WI-A), International Institute for Sustainable Development (IISD), Ducks Unlimited Canada (DUC) and North American Wetlands Conservation Council (NAWCC) formed the Wetlands and Climate Change Consortium. The goals were to assess the degree to which wetland conservation activities were carbon sinks and/or sources, and to assess the potential of crediting conserving wetlands as carbon sinks. The Feasibility Study found that wetlands contain the largest reservoirs of carbon in the terrestrial biosphere, but can function as both sinks and/or sources depending on type and environmental conditions. The study and the Oak Hammock Wetlands and Carbon Sequestration Workshop concluded that wetland conservation and restoration in agricultural landscapes provide significant opportunities to enhance anthropogenic carbon sinks" (Patterson, et al.).

Central Plains, United States

Scientists in the U.S. undertook a wetland restoration study in the northern states of the Central Plains. In 1996 they sampled 204 wetlands and found that undisturbed, pristine wetlands hold twice as much carbon as drained wetland areas converted to agriculture. The study indicates that carbon sequestration in wetlands could be achieved through wetland restoration, but it would likely take 10 years before carbon storage levels returned to those associated with pristine wetlands. The analysis also stressed that dried wetland basins continue to emit carbon after draining.

Source: Wylynko, David. "Prarie Wetlands and Carbon Sequestration: Assessing Sinks Under the Kyoto Protocol." International Institute for Sustainable Development, Wetlands International, Ducks Unlimited. Inc. Sept. 1999.http://www.iisd.org/wetlands/wrkshp_sum.pdf

These, and other studies, imply that it is crucial to preserve wetlands so that they act as a sink, rather than a source of carbon dioxide. Municipal governments should preserve wetlands to contribute to the potential regional benefits of carbon sequestration.

The existing Eugene Wetlands provide a significant opportunity to reduce Carbon by simply maintaining or improving wetland health.

The Eugene Wetlands Bank Program

The Eugene Wetlands Bank program is an example of the efforts already in place in Lane County to restore and continue to provide wetlands as a means of contributing to environmental stability and health. According to the Eugene Wetlands Bank website the Bank serves the following purpose.

> The Bank is a result of the West Eugene Wetlands Plan, which was locally adopted in 1992 and was Oregon's first wetland conservation plan. It is a multiple objective plan that provides a vision for wetlands protection and community development. It identifies about 1,300 acres of wetlands, recommends about 1,000 acres for protection or restoration, and delineates approximately 300 acres of lower value wetlands suitable for future fill and development. The Plan establishes standards for preservation, restoration, and fill of wetlands and describes the processes required for Plan implementation. State and federal laws require compensatory mitigation for the loss of all wetlands regardless of value. Plan policies call for creation of a mitigation bank to help fund restoration and enhancement in conjunction with a program to protect valuable wetlands (West Eugene Wetlands Bank, 2005).

Allowing the existing plants and vegetation to prosper places more Carbon in the ground and less in the air. Research by the Lethbridge Research Center in Canada points to wetland and range restoration and maintenance as a part of Carbon reduction and maintaining current levels:

> Over the centuries, agriculture has contributed to the release of soil-stored carbon into the atmosphere, primarily through cultivation, which results in carbon losses of up to 35 percent. But management practices can maintain carbon stores, and some may even help to increase them. Janzen says grazing management may offer the most practical option for increasing soil carbon storage.
>
> Worldwide, there is about twice as much carbon in soil as in the air, and much of those carbon stores are in rangeland. Grassland soils contain more carbon per unit area than most other ecosystems worldwide (Wetlands and Carbon Sequestration Workshop, 2005).

At a Canadian workshop looking at the place of wetlands in the Carbon sequestration process the "Carbon and Wetlands Sequestration Workshop" Canadian scientist concluded that although wetlands are not part of the Kyoto Protocol recognized Carbon reducers the following remains true:

> Carbon dioxide is by far the most important greenhouse gas influenced directly by human activities (Bruce et al. 1998). The loss and degradation of carbon reservoirs (e.g., wetlands) can result in releases of large amounts of greenhouse gases into the atmosphere, negating gains made from emission reductions. In Canada, the federal government estimates that since 1800, about 20 million hectares, or one-seventh of Canada's total wetland base, have been drained or lost to other land uses. Millions more hectares have been seriously degraded or are at imminent risk (Government of Canada, 1991).

Issues Surrounding Sequestration

Although all evidence presented so far in relation to carbon sequestration has placed a primarily positive spin on the subject skepticism and serious environmental question remain about the validity sequestration. The reliance in lieu of continued use of fossil fuels for energy on sequestration as a method of "pooling carbon" creates serious questions about the long term implications of relying on sequestration of carbon as a fix to global warming issues. The international cooperative group Climenet.org has more available on the long list of questions surrounding carbon sequestration at http://www.climnet.org/CTAP/CTAP.htm .

Conclusion

Lane County and the City of Eugene are already in a good position to use Carbon sequestration as part of a solution to impending greenhouse gas issues. Given the recognition by the Governor's office and the State moving forward with carbon sequestration and mitigation efforts may prove an effective tool in contributing to reducing greenhouse gas emissions in Oregon. It seems a cheep an arguably effective measure to move forward with in Lane County given the additional proven environmental benefits of expanding wetlands and planting trees as a method of improving environmental stability.

Recycling

Curbside Recycling

In Oregon, cities with a population over 4,000 must offer monthly curbside recycling, according to ORS 459A. Recycling can save energy by reducing the fossil fuels needed to extract and manufacture new products and, in the case of paper products, increase carbon sequestered in forests. Recycling also diverts paper, cardboard, and other organic materials from landfills, where they would otherwise decompose and produce methane. Both residences and municipalities benefit from curbside recycling.

Fort Collins, Colorado

In 2002, Fort Collins' residential curbside recycling system collected 7,677 metric tons of materials to be recycled, including more than 4,360 metric tons of newspaper. In addition, citizens participated in the City's leaf drop off, Christmas tree round up, and computer recycling events. Collectively, citizens' recycling activities equate to 20,517 metric tons of CO2 reduced in the year 2002. Source: "City of Fort Collins 2001/2002 Climate Protection Status Report." The City of Fort Collins Energy Management Team. August 2003.

Composting

Composting organic wastes reduces methane emissions and diverts waste from landfills. It also results in lower garbage bills because you'll be reducing the quantity and weight of your trash. This is particularly important in municipalities that have Pay-as-you-Throw programs. Composting benefits internal government operations and community-wide GHG reduction strategies.

Capturing Methane from Landfills

Decomposing trash in landfills produces landfill gas, which is about 50 percent methane. A methane recovery system can be used to harness methane to provide heat, hot water, electricity to a nearby facility.

Short Mountain Landfill – Lane County, Oregon

In the early 1980s, Lane County began exploring the possibility of a Landfill Gas (LFG)-to-electricity facility at its Short Mountain Landfill. In 1985, the county issued a Request for Proposals for facility construction and operation. The Emerald People's Utility District, a local consumer-owned utility serving the county's rural areas, won the contract. The LFG-to-electricity facility began operating in 1992. The facility generates 1.6 megawatts of electrical power, enough for about 800 homes, and will increase its capacity to 4 megawatts by 2010.
Emerald makes roughly 1cts per kilowatt-hour profit on the electricity it sells to the Bonneville Power Administration. This is basically the difference between 4.5 cents, which is Bonneville's alternative cost of producing electricity, and 3.5 cents, which is Emerald's cost to produce electricity. Emerald's total 1992 revenues were about $150,000. Lane County receives a minimum royalty of $15,000 per year and avoids having to build and operate an expensive collection system. Source: University of Florida. "Tomorrow's Energy Today for Cities and Counties: Using Landfill Gas for Energy: Projects that Pay." IFAS Extension. http://edis.ifas.ufl.edu/EH275

St. John's Landfill – Portland, Oregon

In 1991, Metro began a $36 million closure project of the landfill that involved capping the landfill with earth and vegetation and constructing a 9,400-foot pipeline to deliver methane from the landfill to a local cement kiln. Completed in 1998, the project is highly successful, diverting 1.5 million cubit feet of landfill gas from the atmosphere per year. The energy captured from the gas is equivalent to 8 million therms of natural as per year - enough to serve 3,500 Portland homes. Carbon dioxide reductions from the utilization of the energy in landfill gas are estimated to be 23,000 metric metric tons per year.

Source: City of Portland. "Carbon Dioxide Reduction Strategy: Success and Setbacks." Portland Energy Office. June 2000. http://www.sustainableportland.org/co2update2000.pdf

WasteWise

Wastewise is a free, voluntary, EPA program through which organizations eliminate costly municipal solid waste by designing their own waste reduction programs tailored to their needs. Municipal solid waste includes materials that would otherwise end up in a landfill, such as corrugated cardboard, paper, yard trimmings, packaging, wood pallets, and non-hazardous substances. Waste reduction can save an organization money through reduced purchasing and waste disposal costs.

For more information about wastewise and its relation to global warming visit *http://www.epa.gov/epaoswer/non-hw/reduce/wstewise/pubs/wwupdate18.pdf*

Pendleton, Oregon

The Confederated Tribes of the Umatilla Indian Reservation reuse milk jugs as slow-watering irrigation devices and as warning signs to cattle near barbed-wire fences. The tribal operations manager promotes reuse by running an informal materials exchange via e-mail. The reservation's quarterly newspaper, The Tribal Environmental Recovery Facility, educates residents about waste prevention and highlights the community's progress in reaching its substantial waste reduction goals. With the installation of a new recycling and waste disposal facility, residents now have the option of dropping off recyclables or ordering curb-side pick-up. This center collected nearly 15 metric tons of paper products and 30 metric tons of metal for recycling in 2001. The tribe purchases recycled products whenever possible.

Source: EPA WasteWise. "2002 Annual Report." Environmental Protection Agency. 2002. http://www.epa.gov/wastewise/pubs/progrpts/pdfs/report8.pdf#page=4

Pay-As-You-Throw

EPA provides technical and outreach assistance to encourage local governments to implement pay-as-you-throw systems for managing solid waste in their communities. With pay-as-you-throw, residents are charged based on the amount of waste they discard. This system creates an incentive for residents to generate less trash and recycle more. Currently, over 5,000 pay-as-you-throw communities exist in the United States. On average, communities with pay-as-you-throw see waste reductions of 14 to 27 percent. Eugene, Oregon has implemented this program since 1992.

Vancouver, Washington

In 1990, Vancouver introduced an incremental rate structure that made the rate for a second trash can 84 percent higher than the first can. In just 15 months, the city experiences a 13-percent decrease in the number of customers choosing the one can basic service and a corresponding decrease in customers choosing the two-can service. Today the city has a variety of trash can sizes to accommodate individual household and business needs. In 1992, the city also implemented a curbside recycling program for recyclables including yard debris. By the end of 1995, the city has achieved a 51 percent recycling rate.

Source: Canterbury, Janice. "Pay-as-you-throw: A growing MSW management success story." Resource Recycling. October 1997. http://www.epa.gov/epaoswer/non-hw/payt/pdf/rr1097.pdf

Private Sector Greenhouse Gas Emission Reduction Strategies

Many businesses and academic institutions are taking proactive approaches to climate protection by implementing greenhouse gas emission reduction goals and strategies. In doing so, they are setting examples for how other businesses can follow in their footsteps. Many are also finding significant cost savings through the process. This section of the report provides examples of the actions leading businesses are taking to address for climate change. It has been organized into three sections: products and services, manufacturing, and academia.

Products & Services

DuPont

Operating in more than 70 countries, DuPont offers a wide range of innovative products and services for markets including agriculture, nutrition, electronics, communications, safety and protection, home and construction, transportation and apparel.
The company motto is that they put science to work by creating sustainable solutions essential to a better, safer, healthier life for people everywhere.

DuPont began an ambitious carbon dioxide and energy reduction program 10 years ago that today has brought greenhouse gas emissions down 70 percent; in the same period, production increased almost 30 percent. These carbon-reduction and energy-efficiency measures have produced significant financial benefits for DuPont. In addition to cumulative energy savings of more than $2 billion, renewable energy saves $10 million annually over fossil fuels. DuPont also hopes to realize $40 million in coming years from trading carbon emissions credits. To underscore its commitment to this new commodities market, the company became a charter member of the Chicago Climate Exchange, a pilot program for greenhouse gas emission reduction and trading. Specifically, by 2010, DuPont's goals are:

1) Reduce global carbon-equivalent greenhouse gas emissions by 65 percent using 1990 as a base year
2) Hold total energy use flat using 1990 as a base year
3) Derive 10 percent of their global energy use in the year 2010 from renewable resources

Source: DuPont. "Global Climate Change." June 2001.
http://www1.dupont.com/NASApp/dupontglobal/corp/index.jsp?page=/content/US/en_US/news/position/global_climate.html

Northrop, Michael. "Benefits of Cutting Emissions." *Washington Post*. *28 February 2005.*

Dow

Dow is a leader in science and technology, providing innovative chemical, plastic and agricultural products and services to many essential consumer markets. With annual sales of $40 billion, Dow serves customers in 175 countries and a wide range of markets that are vital to human progress: food, transportation, health and medicine, personal and home care, and building and construction, among others. Committed to the principles of sustainable development, Dow and its 43,000 employees seek to balance economic, environmental and social responsibilities.

In 2001, a detailed strategy was developed with four key elements, each with actionable objectives. Dow's efforts to reduce its footprint on the global climate accelerated in 2002, delivering the following progress:

1) Technology - In 2002, Dow identified products and process improvements that reduce carbon emissions. For example, they are exploring advanced catalysts to convert alternative raw materials into chemical feedstocks while reducing energy inputs and greenhouse gas emissions. Proposals have been made to government agencies in both Europe and the U.S. for joint participation in this research. Dow also began efforts to meet more of its energy needs through renewable sources. A Dow team has entered into an agreement to harness landfill gas to power a manufacturing site. Wind and fuel cell projects are also being developed.

2) Business Integration - All Dow businesses have been instructed to incorporate consideration of global climate change into their strategic plans. The level of climate change consideration is evaluated as they measure progress toward implementation of Dow's Sustainable Development Operating Plan. In 2002, work was initiated to determine how to establish an internal price signal for carbon. While economic conditions have slowed the work in this area, some businesses are informally considering the cost of carbon in their proposals for energy reduction projects. In late 2002, Dow developed the role of "Greenhouse Gas Champion" to help improve internal greenhouse gas accounting systems and create tools that will help businesses identify reduction opportunities.

3) New Products - A number of Dow teams are exploring new business opportunities, leveraging Dow expertise to develop new products or services with the global climate in mind. One team exploring energy opportunities has set carbon reduction or neutral carbon impact as a criterion for pursuing new opportunities. Dow's Growth Center is exploring opportunities to make chemicals from biomass and has been working with environmental groups to help identify areas of the world where an abundance of waste organic materials are available to serve as building blocks for this new chemistry. In the transportation sector, Dow Automotive is working with its customers in the European and U.S. auto industry on technologies that will lower greenhouse gas and other air emissions from cars and trucks.

4) Stakeholder Involvement - Dow has made numerous presentations to external groups to describe its climate change strategy. Members of Dow "Solutions" teams have engaged in dialogue with environmental groups to help identify opportunities for change that are beneficial to the climate as well as to Dow. In late 2002, Dow became a member of the World Resource Institute (WRI) Green Power Market Development Group, a small group of forward thinking companies that is exploring ways to promote greater use of renewable energy. Dow is also actively participating in the development of voluntary

climate change initiatives sponsored in the U.S. by the Business Roundtable (BRT) and the American Chemistry Council (ACC). These initiatives will encourage greater action by broader segments of American industry. In 2002, Dow has responded to information requests from numerous groups. For example, the Friends of the Earth requested that Dow include a discussion of its climate change benefits and liabilities in its official filings with the U.S. Securities and Exchange Commission (SEC). Dow also submitted a detailed response to a survey by the Carbon Disclosure Project, which represents a group of institutional investor groups concerned about climate change. That response can be found at www.cdproject.net.

In Europe and Canada, progress continues to be made on climate change policy. In addition to participating in voluntary climate change programs in Canada, the Netherlands, the United Kingdom, and Germany, Dow is working to assure that any mandatory programs do not competitively disadvantage them. The Dow Climate Change Team will continue to drive and monitor progress in 2003.

Between 1994 and 2002, Carbon Dioxide levels have fluctuated between 26.1 and 30.9 millions of metric metric tons of CO2 equivalent. However, total greenhouse gas emissions have nearly been reduced by half from 14.1 (1994) to 7.7 (2002) million metric metric tons of CO2 equivalent.

Source: "Climate Change." The Dow Global Public Report - Environmental Stewardship. 2002
http://www.dow.com/publicreport/2002/stewardship/climate.htm
http://www.dow.com/publicreport/2002/stewardship/emissions.htm

Progressive Investments

Since 1982 Progressive Investments has offered socially responsible portfolio management services to individuals and institutions. They are actively involved in the socially responsible investment community, promoting corporate responsibility through social screening and shareholder activism. Progressive Investments also encourage targeted community investments. In 1999 they founded Portfolio 21, a no load global equity fund investing in companies throughout the world that are incorporating environmental sustainability into their business strategies. During 2004 they started a new company, Upstream 21, which will direct capital to small business supporting environmental sustainability in the local economy.

In 2000, Progressive Investments developed a Carbon Offset Program to measure the organization's direct impact on global warming and to mitigate these emissions by purchasing carbon offsets. Two areas of concentration were selected: emissions associated with electricity use in various offices, and emissions associated with commuting and work-related travel.

They purchase blocks of renewable energy (generated from wind and salmon-friendly dams) from the electrical utility for electricity use in their offices where this option is available. The electricity used in excess of these green energy blocks is offset through their carbon mitigation program.

Progressive Investments have also increased teleconferencing and shifted travel to modes with less environmental impact whenever possible. They mitigate the carbon emissions associated with the travel that cannot be avoided. The cost of mitigation is actually very low, so they multiply the cost figure from travel mitigation by a factor of ten. Multiplying carbon emissions recognizes the additional environmental impacts associated with travel. Progressive Investments provides incentives to minimize single occupancy vehicle travel by reimbursing the cost of public transportation for employees. They also make contributions toward bicycle maintenance for any employee who commutes by bike. To enable employees to leave their cars at home and take alternative transportation to work, the company has joined Flexcar's car-sharing program. There is a hybrid-electric vehicle at the Natural Capital Center for Flexcar member use.

"In 2004 Progressive Investment Management emitted 100 metric tons of CO2 due to travel and 17 metric tons of CO2 due to energy use (we purchase renewable energy for much of our energy use, and there are insignificant CO2 emissions associated with that). After multiplying our business emissions by a factor of 10 (to make the number large enough to motivate change, and also to recognize other environmental impacts associated with travel and energy use beyond CO2 emissions), and adding some personal travel, we spent a total of $12,864.76 on mitigation efforts. The money was divided as follows -- Purchase of 678 metric tons of CO2 offsets (almost 7 times our actual business emissions) from the Climate Trust and donations totaling $ 6,429.36 to the Oregon Environmental Council, the Green House Network and the NW Earth Institute -- all groups working on education, outreach and policy initiatives to address global warming issues.
To sum up, Progressive Investment Management has been offsetting its carbon emissions since 2000 and we have been carbon neutral (offsetting emissions associated with travel and energy use at all of our offices) since 2001."[1]

Source: "Greenhouse Gas Reduction." Progressive Investment Management.
http://www.progressiveinvestment.com/sub.php?id=432

Norm Thompson Outfitters

Based in Portland, Oregon, Norm Thompson publishes three catalogues: Norm Thompson, Solutions, and Early Winters. Norm Thompson plans to offset 100 percent of its annual direct greenhouse gas emissions by 2006 through the purchase of renewable energy certificates. The company believes that global climate change is among the most imminent threats to the planet and its people, as well as Norm Thompson's own business interests. By purchasing green power, Norm Thompson hopes to help convert fossil fuel-based power grids to clean, renewable energy sources. Norm Thompson Outfitters is also a leader in the catalog industry in making the changeover to recycled paper, helping to lessen the environmental burden at no loss to their profitability. The Alliance for Environmental Innovation estimates that Norm Thompson's switch to recycled paper for their catalogs means an annual savings of 4,400 metric tons of wood, 20 billion BTUs of energy, 11.7 million gallons of wastewater and 990 metric tons of solid waste.

[1] Email communication on March 2, 2005 with Scott Pope, Progressive Investment Management

Source: Norm Thompson Outfitters. Green Power Partnership." Environmental Protection Agency. 15 February 2005.
http://www.epa.gov/greenpower/partners/partners/normthompsonoutfitters.htm

Manufacturing

Nike

Nike is the world's most competitive sports and fitness company employing 23,000 people worldwide. The World Headquarters is in Beaverton, Oregon but the Pacific Northwest is Nike's hometown with their business spreading around the globe.

Nike is working to reduce emissions not just from Nike-owned facilities, but eventually from contract factories and processes throughout their supply chain. To do this effectively, Nike has found it helpful to rely on partners in the environmental community.

1) World Wildlife Fund's (WWF) Climate Saver's Program - Much of the work on climate change unfolds in the context of Nike's relationship with World Wildlife Fund (WWF), and its Climate Savers program, which they joined in 2001. Working together, Nike has established a set of short- and mid-term goals, including the following:
    a. Reduce GHG emissions from Nike-owned facilities larger than 20,000 sq. ft. (1860 m2) and business air travel by 13% below 1998 levels by the end of 2005.
    b. Determine baselines for GHG emissions from contract manufacturing facilities producing Nike-branded footwear and apparel.
    c. Determine baselines for our GHG emissions from logistics encompassing the movement of finished products to customer warehouses.

2) Business for Social Responsibility's (BSR) Clean Cargo Project – Nike works closely with Business for Social Responsibility (BSR), as a charter member of their "Clean Cargo" project. In November 2003, Clean Cargo project members released the Clean Cargo Environmental Performance Survey (EPS), a new information tool that will help gauge environmental management performance and address the environmental impacts of ocean-going shipping. To learn more about the Environmental Performance Survey, go to www.bsr.org/sustainabletransport. Nike is also participating in a companion group at BSR called "Green Freight" which applies a similar approach to the movement of products via ground transportation within the United States.

3) Government Programs in the US - At Nike's world headquarters in Oregon, they continue to reduce the percentage of employees who drive alone to work. In 2001, their drive-alone rate was 76%, a drop of 22% from their first measurements in 1992.

   Nike's USA Delivery organization has a voluntary agreement with the EPA focusing on ground transportation, called the SmartWay program. Nike and other SmartWay partners have agreed to work with the EPA to develop performance measures or goals to improve air quality, reduce greenhouse gas emissions, save fuel, and protect public health.

Using an innovative mechanism devised by the Oregon Office of Energy, Nike is redirecting $1 million of its state income tax liability directly to Oregon public schools. The Business Energy Tax Credit (BETC) reduces tax bills for companies that invest in energy-saving projects; the reductions are meant to offset some of the higher initial costs of a more efficient system. In 2002, Nike began giving what would have been state taxes directly to schools, paying for 27% of an energy-efficiency upgrade in schools across the state. Schools get improved learning environments and reduced operating costs, and Nike gets to dedicate a portion of its state taxes to help schools.

4) Eco-Class Program - Employees in the United States who travel for Nike business have the option of choosing Delta Air Lines to allocate a portion of their ticket cost to a fund established by Nike and Delta Air Lines. The Eco-Class fund is aimed at mitigating the annual climate impact of Nike's air travel on Delta flights by offsetting the equivalent carbon emissions. Eco-Class began in 2001, with the first fund enabling a local middle school near Nike's world headquarters in Beaverton, Oregon to change its fuel source from oil to natural gas. In 2002 and 2003, the Eco-Class funds were donated to The Climate Trust, a Portland, Oregon-based non-profit organization committed to reducing greenhouse gas levels through a portfolio of projects aimed at offsetting carbon emissions. In the future, Nike Travel hopes to expand on the Eco-Class program's success by growing Nike's portfolio of environmental travel partners to include other preferred suppliers.

Source: "Environment: Climate Impact." Nikebiz. January 2004. http://www.nike.com/nikebiz/nikebiz.jhtml?page=27&cat=climate

Baxter International Inc.

Baxter International Inc. is a global health-care company that, through its subsidiaries assists health-care professionals and their patients with treatment of complex medical conditions including hemophilia, immune disorders, kidney disease, cancer, trauma and other conditions.

Baxter is a member of the Business Environmental Leadership Council (BELC) of the Pew Center on Global Climate Change, which commits to taking action to address climate change.

Essentially all of Baxter's company-controlled GHG emissions in 2003 were comprised of carbon dioxide that is related to energy usage. The company's energy conservation activities to improve facility energy efficiency are a key component of Baxter's GHG management strategy. In addition, Baxter is expanding the use of green building concepts, considering CO2 emission rates of purchased power, evaluating certain renewable energy technologies, piloting certain solar installations and participating in a number of national and international climate organizations.

In addition to being a member of BELC, Baxter is also a founding member of the Chicago Climate Exchange (CCX). Baxter became a member of CCX on Jan. 16, 2003. CCX is the first U.S. private, voluntary program designed to allow members to cap and trade their GHG emissions. In trading emission credits, participating companies that cost-effectively reduce their emissions below their target can sell those extra reductions as credits to companies that are not able to meet their target. The program is open to all companies with operations in Canada, the United States and Mexico.

The members of CCX are committed to either reduce emissions by one percent per year during a four-year period or to purchase sufficient carbon credits to meet their obligation under the program. In 2003, Baxter's first year in the program, Baxter successfully defined baseline emissions, determined annual GHG target levels, and worked with independent external GHG auditors to assure total program robustness in an established financial market. Baxter purchased 3.3 metric metric tons of GHG emissions credits in 2003 to meet its obligations under the program.

Baxter's CCX carbon-trading experience and its participation on select CCX member committees has positioned the company well to respond to other quickly emerging global carbon cap-and-trade initiatives. For instance, in October 2003, the European Union (consisting of 25 member states as of May 1, 2004) passed the EU Emissions Trading Directive. Under this directive, the EU established a mandatory carbon cap-and-trade scheme beginning in January 2005. Phase one (2005 –2007) initially will include the very largest GHG emitters. Phase two (2008 –2012) is expected to include many additional GHG emitters, including the operations of many multinational companies, such as Baxter.

Source: "Sustainability: Our Environment: Greenhouse Gas Emissions and Climate Change. Baxter."
http://www.baxter.com/about_baxter/sustainability/our_environment/environmental_impacts/climate_change/

Intel

Intel is a high technology industry supplying the computing and communications industries with chips, boards, systems, and software building blocks that are the "ingredients" of computers, servers and networking and communications products. These products are used by industry members to create advanced computing and communications systems.

The Intel Corporation has signed a formal PFC (perfluorocompounds - a class of synthetic inert gasses used in many applications that are associated with global climate change) reduction agreement with the U.S. EPA and the World Semiconductor Council. This voluntary action was taken despite the fact that the U.S. semiconductor industry is estimated to contribute less than 0.2% of all greenhouse gas emissions. In this "groundbreaking" agreement, Intel and most of the world's semiconductor manufacturers have agreed to reduce emissions of PFCs 10% below their 1995 levels. Because of the projected growth of Intel, the company will have to achieve greater than 90% reduction in PFC emissions per silicon wafer to reach the goal set in the agreement. In addition to the World Semiconductor Council agreement on PFCs, Intel has recently established a goal to reduce it's energy consumption by 4% per year, normalized to production. Intel is also working hard to reduce the energy demand of our products. Several years ago the U.S. EPA acknowledged our efforts by awarding us a Climate Protection Award for Intel's Instantly Available Personal Computer (IAPC) technology.

IAPC technology allows a PC to power down to sleep mode (less than 5 watts) when not in use and quickly awakens in seconds. This feature reduces computer power consumption to five times less than the current Energy Star standard. The U.S. EPA estimates that if all PC's in the U.S. used IAPC technology, this would reduce emissions from energy generation equivalent to removing 500,000 cars from the U.S. roads and would save $300 million in energy costs. In 2004 Intel was recognized by the U.S. Secretary of Energy for their efforts to improve the energy efficiency of internal power supplies used in personal computers.

Source: "Environmental, Health and Safety2003 Report." Intel. http://www.intel.com/intel/other/ehs/product_ecology/globalclimate.htm

Academia

University of British Columbia

The University of British Columbia is on track to meet and surpass the 2012 target of reducing greenhouse gas emissions by 25 percent. Since 1998, despite a 19 per cent increase in students, it has reduced CO2 emissions from buildings and transportation by seven percent and reduced energy use in core and ancillary buildings by eight per cent (for a savings of $5.4 million). Last year, UBC was the first and only Canadian university to receive Green Campus Recognition from the U.S.-based National Wildlife Federation. Much of the progress has been accomplished through major initiatives including an infrastructure upgrade called EcoTrek, the development of "green" buildings, and University Town -- an overall plan to transform UBC from a commuter campus into a sustainable work-live community. The Life Sciences Centre, UBC's recently opened and largest campus building, will be certified at the Leadership in Energy and Environmental Design (LEED) silver rating. LEED is widely recognized as a leading international green building evaluation system. Designed to achieve major energy and water savings by 2006, EcoTrek will reduce CO2 emissions by about 15,000 tonnes each year, and generate annual savings of approximately $2.5 million.

With an anticipated 20,000 people living on campus by 2010, the University Town plan includes the development of eight residential and mixed-use neighborhoods featuring student, faculty and staff housing, university-related shops and services, a community centre, a school and a range of public amenities. The plan calls for a minimum of 50 percent of households to include at least one resident who works or studies at UBC, with the aim of substantially reducing automobile traffic to and from the campus. Since 1997, through transportation initiatives like U-Pass that provides all students with an affordable monthly transit pass, UBC has seen transit ridership increase by 163 per cent, and automobile traffic decrease by 13 per cent.

Source: "USB on Track to Surpass Kyoto 2010 Emissions Targets." Canada Learning News. 15 February 2005. http://tinyurl.com/6q9qw

REFERENCES

Part I

Climate Impacts Group (CIG), University of Washington. Homepage. Accessed 7 March 2005. http://www.cses.washington.edu/cig/

Gedalof, Ze'ev, David L. Peterson, and Nathan J. Mantua. 2004. “Columbia River Flow and Drought Since 1750.” *Journal of the American Water Resources Association 40, no.6: 1579-1592.*

Governor´s Advisory Group on Global Warming, State of Oregon. 2004. Oregon Strategy for Greenhouse Gas Reductions. Adopted 17 December 2004. http://egov.oregon.gov/ENERGY/GBLWRM/docs/GWPlan.pdf

Hansen, James E. 2005. Global Temperature Trends: 2004 Summation. Webpage. NASA Goddard Institute for Space Studies Website. Accesssed 7 March 2005. http://www.giss.nasa.gov/data/update/gistemp/2004/.

Institute of Natural Resources (INR). 2004. Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest. Institute of Natural Resources, Oregon State University. http://inr.oregonstate.edu/policy/climate_impacts_consensus_statement.pdf

International Council for Local Environmental Initiatives (ICLEI). *About the CCP*. Web Page. ICLEI Website. Accessed 7 March 2005. http://www.iclei.org/co2/background.htm

Moberg, Anders, et al. 2005. Highly variable Northern Hemisphere temperatures reconstructed from low- and high-resolution proxy data. *Nature* 433, no. 7026: 613-617.

Mote, Phil. “Re: update and questions.” E-mail to Bob Doppelt. 17 February 2005.ebsite. Accessed 7 March 2005. y of WAshington ing about 1,000 years ago the second and their warmest years. s, and other real

National Center for Atmospheric Research (NCAR). Homepage. Accessed 7 March 2005. http://www.ncar.ucar.edu/

Sonntag-O’Brien, V. 1997. “Local Governments Lead the Way in Combating Global Climate Change.” *Climate Change: Mobilizing Global Effort*. Paris: OECD.

Watson, Robert T, ed. 2001. *Climate Change 2001: Synthesis Report.* Intergovernmental Panel on Climate Change (IPCC). http://www.grida.no/climate/ipcc_tar/vol4/english/index.htm

Part II

Pew Center on Global Climate Change, "A Synthesis of Potential Climate Change Impacts on the US."

Abbot, M. 2004. Impacts of Climate Change on Coastal Ocean. Presentation at the June 14, 2004 Impacts of Climate Change on the Pacific Northwest Meeting, Oregon State University, Corvallis Oregon. http://inr.oregonstate.edu/policy/climate_abbott_files/frame.htm

Angermeyer, Don. Telephone interview. 7 Feb. 2005.

AVMA Study: West Nile virus cost equine industries in Colorado, Nebraska millions in 2002. www.avma.org/onlnews/javma/jun03/0306151.asp

Bouchama M.D., A. and J. P. Knochel, M.D. 2002. Heat Stroke. Accessed 26 Feb 2005. http://content.nejm.org/cgi/content/extract/346/25/1978

Bunyavanich, Mphil, S., C.P. Landrigan, P.MD., MPH, A.J. McMichael, M BBS, PhD., P.R. Epstein, MD, MPH. 2003. The Impact of Climate Change on Child Health. Ambulatory Pediatrics 3:47,49.

Capen, David. Telephone interview. 7 Feb. 2005.

Climate Change 2001: Impacts, Adaptation and Vulnerability. www.grida.no/climate/ipcc_tar/vol4/english/114.htm

Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Report for the US Global Change Research Program

Climate Change in Oregon, US EPA, September. (1998). http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/SHSU5BVJZ4/$File/or_impct.pdf

Climate Impact Group. 29 July 2004. Overview of Climate Change Impacts in the U.S. Pacific Northwest. University of Washington. http://www.cses.washington.edu/db/pdf/cigoverview353.pdf

Climate Impacts Group. [no date provided] Climate Impacts on Pacific Northwest: Forests. http://www.cses.washington.edu/cig/pnwc/pnwforests.shtml

Climate Impacts Group. [no date provided] Connecting Climate and Society. http://www.cses.washington.edu/db/pdf/CIG_Connecting237.pdf

Climate Impacts Group. Climate Impacts on Pacific Northwest: Water Resources. http://www.cses.washington.edu/cig/pnwc/pnwwater.shtml

Climate Impacts Group: Climate Impacts. http://www.cses.washington.edu/cig/ Mar 3, 2005.

Comrie, Andrew C. and Korine N. Kolivras. Climate And Infectious Disease In The Southwestern US. Progress in Physical Geography.

Cornell Developing Climate-Based Data Warning System. www.environmentalrisk.cornell.edu/WNV/WNV-L…/6-20-03b.htm

Cornell News. 2003. Cornell Scientists Developing Online West Nile Virus Climate Based Data Warning System. http://www.cornell.edu/releases/June03/WestNileClimate.bpf.html

Dean Runyan Associates. "Lane County: Travel Impacts, 1991-2003."

Environmental Protection Agency. (1998, September). Report on climate change and Washington.

Environmental Protection Agency. Report on climate change and Oregon. September 1998.

Facts and Figures. 2003. Eugene Water & Electric Board (Eweb). Web Page EWEB Website Accessed 26 Feb 2005. <http://www.eweb.org/about/facts/EWEB_Facts.pdf>

Fazio. 2004. Potential Impacts of Climate Change in the Pacific Northwest. Draft. for the Convention and Visitors Association of Lane County, Feb. 1994.

Global Climate Change and Wildlife in North America. Wildlife Society. http://www.uoregon.edu/~bdopplet/Climate_change_and_Wildlife_Society_Report.pdf

Haub, C. 1995. Global and US Population Trends. Accessed 26 Feb 2005. <http://gcrio.org.org/CONSEQUENCES/summer95/population.html

Intergovernmental Panel on Climate Change. Climate Change 2001: Impacts, Adaptation, and Vulnerability. A Report of Working Group II of the Intergovernmental Panel on Climate Change.

Intergovernmental Panel on Climate Change. (2001). Climate Change 2001: Impacts, Adaptation, And Vulnerability. A Report Of Working Group II Of The Intergovernmental Panel On Climate Change. http://www.ipcc.ch/pub/taroldest/wg2/010.htm

JAVMA News. 2003. Study: West Nile Virus cost equine industries in Colorado, Nebraska millions in 2002. http://www.avma.org/onlnews/javma/jun03/0306151.asp

JISAO Climate Impacts Group. [no date provided] Impacts of Climate Variability and Change in the Pacific Northwest. University of Washington. http://www.cses.washington.edu/db/pdf/moteetalgreenbook96.pdf

Lane County, Oregon's Public Health Response to West Nile Virus. 2004 www.co.lane.or.us/cao_pio/westnilevirus/5_lanecounty.htm

Miles, Edward. 15 June 2004. Climate change impacts in the Pacific Northwest. Presentations and Extended Abstracts by Presenters at the Impacts of Climate Change on the Pacific Northwest Meeting. Powerpoint presentation. http://inr.oregonstate.edu/policy/climate_miles_files/frame.htm

Miles. E; Henry. B, and Simpson. C, 1998. Pacific Northwest Regional Workshop on Climate Change Impacts

Miller, Ron. Telephone Interview. 9 Feb. 2005.

Mimikou, MA and EA Baltas. Climate Change Impacts On The Reliability Of Hydroelectric Energy Production.

Nelson, Arno. Telephone Interview. 8 Feb. 2005.

NRDC. 2004. Consequences of Global Warming. Accessed 26 Feb 2005. http://www.nrdc.org/globalWarming/fcons.asp

OEC. Global Warming/Transportation; Oregon Environmental Council (www.orcouncil.org)

Oregon Department of Agriculture. www.oregon.gov/ODA

Oregon State University, Institute for Natural Resources. "Scientific Consensus Statement On Likely Impacts Of Climate Change On The Pacific Northwest." 2004. http://inr.oregonstate.edu/policy/climate_impacts_consensus_statement.pdf

Palmer, Susan. Dead zone appears off coast, puzzles scientists. Register-Guard, Aug. 10th 2004.

Perini. C, Mark A. Bernstein, Andrea Mejia, Howard Shih, Fred Rueter, Wilbur Steger.2002 RAND Science and Technology, "Generating Electric Power in the Pacific Northwest Implications of Alternative Technologies".

Pernin.c, Bernstein.M, Mejia.A, Shih.H, Rueter.F, Steger.W.2002, RAND Science and Technology.

Physicians for Social Responsibility and Oregon Advisory Board, Health Effects Of Climate Change And Energy In Oregon. February 2002.

Runyan, Dean. Lane County Travel Impacts. February, 2005.

State Pirgs: Working Together. 2005. A History of Energy Problems. http://www.pirg.org/jobs/cleanenergy/

The Potential Impacts of Climate Variability and Change on Temperature-Related Morbidity and Mortality in the United States. By: McGeehin, Michael A.; Mirabelli, Maria. Environmental Health Perspectives Supplements

U.S. Department of Transportation: The Potential Impacts of Climate Change on Transportation: Workshop Summary and Proceedings. 2002.

U.S. Environmental Protection Agency, 2004; Heat Island Effect. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsLocalHeatIslandEffect.html

Upton, Harry. Oregon Office of Fish and Wildlife. February, 2005.

USDA, National Agricultural Statistics Service. 2002 Census of Agriculture- County Data.

Villeneuve, Daniel L. Environmental Stresses and Skeletal Deformities in Fish from the Willamette River, Oregon, USA. Oregon State University. June, 15 2004.

Vulnerability of Waterborne Diseases to Climate Change in Canada: A Review; Charron, Dominique F; Thomas, M. Kathleen; Waltner-Toews, David; Aramini, Jeffery J.; Edge, Tom; Kent, Robert A.; Maarouf, Abdel R.; Wilson, Jeff. Journal of Toxicology & Environmental Health: Part A.

Vulnerability Of Wind Power Resources To Climate Change In Continental US. Renewable Energy: An International Journal

Water Supply and Facilities. Draft November 22, 2004. Region 2050 Alternative Growth Scenarios Evaluation, Approach, Assumptions, and Issues. http://www.region2050.org/pdf/meetings/112004/WaterASSESS.pdf>

Whitmore, Susan, and Goodstein, Eban; The Value Of Oregon Beaches: An Analysis Of The Non-Market Costs Of Climate Change On Oregon Coastal Beaches. Lewis and Clark College. May 2004.

Part III

Cities for Climate Protection (CCP). 2003. City of Charleston Local Action Plan on Climate Change. Prepared by Tommy Linstroth. http://www.cofc.edu/sustainability/Charleston_SC_%20LAP.pdf

Cities for Climate Protection (CCP). CCP Five-Milestone Framework. Webpage. Accessed 8 March 2005. http://www.iclei.org/co2/five_milestones.htm.

Cities for Climate Protection Greenhouse Gas Emissions Software. Developed by Torri Smith Associates. January 2004.

City of Fort Collins, Energy Management Team. 2003. City of Fort Collins 2001/2002 Climate Protection Status Report.

City of Fort Collins. 2003. City of Fort Collins 2001/2002 Climate Protection Status Report. August 2003.

Department of Energy (DOE). 1997. Voluntary Reporting of Greenhouse Gases. DOE/EIA-0608(97).

Eugene Water & Electric Board (EWEB). 2003. Facts and Figures. http://www.eweb.org/about/facts/EWEB_Facts.pdf

Gaffin, Stuart R. 1995. Comparing CH4 Emissions from Hydropower to CO2 from Fossil Fuel Plants. Submitted to World Commission on Dams Thematic Review of Dams and Global Change. Produced by Atmosphere Program, Environmental Defense Fund.

Graham-Rowe, Duncan. 2005. Hydroelectric power's dirty secret revealed. *New Scientist*. 26 February 2005.

IPCC. 1995. Climate Change 1995: The Science of Climate Change (1996) [Houghton, J. T., L. G. Meira Filho, B. A. Callander, N. Harris, A . Kattenberg and K. Maskell (eds.)]. Cambridge University Press, Cambridge, UK. 572 pp.

IPCC. 1996. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Website. Accessed 1 April 2005. <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>

Oregon Climate Service, Oregon State University. Eugene Daily Data. Website. Accessed 4 March 2005. http://www.ocs.orst.edu/eug_dly.html.

Sonoma County, Waste Management Agency. 2003. Greenhouse Gas Emission Inventories for Eight Cities in Sonoma County, California. http://www.skymetrics.us/standing-together/reports/pdf%20GHGInventoryReport9-03.pdf

U.S. Census Bureau, Population Division. 2004. Table 4: Annual Estimates of the Population for Incorporated Places in Oregon, Listed Alphabetically: April 1, 2000 to July 1, 2003 (SUB-EST2003-04-41). Release Date: June 24, 2004. http://www.census.gov/popest/cities/tables/SUB-EST2003-04-41.pdf.

U.S. Environmental Protection Agency (USEPA), Office of Policy Planning and Evaluation. 1998. Inventory of the U.S. Greenhouse Gas Emissions and Sinks 1990-1996.

United Nations Framework Convention on Climate Change (UNFCCC). 1998. Kyoto Protocol. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/07a01.pdf

Part IV References

ARISE Technologies Corporation. "Success Stories." http://www.arisetech.com/Solar_Info/Success_Stories.html

Barrier Systems Inc. "Success Stories." 2003. http://www.barriersystemsinc.com/success/story.asp?key=7

Canterbury, Janice. "Pay-as-you-throw: A growing MSW management success story." Resource Recycling. October 1997. http://www.epa.gov/epaoswer/non-hw/payt/pdf/rr1097.pdf

Cathcart, J.F. Carbon Sequestration: A Working Example in Oregon. Journal of Forestry. Vol. 98, no. 9. pp.32-37, Sept. 2000.

Cathcart, Jim. Forests, Carbon and Global Climate Change. (Online). September, 2000. The Journal of Forestry.

Cathcart, Jim. Forestry and Wood Products. (Online). March, 1 2005. Sustainable Oregon. http://www.sustainableoregon.net/forestry/carbon_seq.cfm

City of Portland. "Carbon Dioxide Reduction Strategy: Success and Setbacks." Portland Energy Office. June 2000. http://www.sustainableportland.org/co2update2000.pdf

Department of Energy. Oregon Strategy for Greenhouse Gas Reduction. October, 13 2004 (Online). March, 1 2005. http://www.energy.state.or.us/climate/Warming/Report/MainReport.htm

EPA WasteWise. "2002 Annual Report." Environmental Protection Agency. 2002. http://www.epa.gov/wastewise/pubs/progrpts/pdfs/report8.pdf#page=4

Fort Collins. "Colorado Existing Emission Reduction Measures." http://fcgov.com/airquality/pdf/ch3-exist.pdf

Fort Collins. "Measures to Reduce Greenhouse Gases from Energy Use." http://fcgov.com/airquality/pdf/ch6-energy.pdf

Goodstein, Eban, and Laura Matson. The Costs of Climate Change in the Pacific Northwest: Municipal Water Supply & Flooding.

Green Team. “Sustainable Portland.” Energy Division. http://www.sustainableportland.org/energy_gov_green.html

Heckeroth, Steven. “Solar Building Design.” Backwoods Home Magazine. http://www.backwoodshome.com/articles/heckeroth63.html

ICLEI. “Alternate Commute Program.” 1995-2004. http://www.iclei.org/cases/c005-acp.htm

ICLEI. “Conservation Power Financing Program (PFP).” 1995-2005. http://www.iclei.org/cases/c013-smu.htm

ICLEI. “Conservation Power Financing Program (PFP).” 1995-2005. http://www.iclei.org/cases/c013-smu.htm

ICLEI. “Green Fleets Program.” 1995-2005. http://www.iclei.org/cases/c002-dgf.htm

ICLEI. Trip Reduction Program. 1995-2001. http://www.iclei.org/cases/c003-trp.htm; Pew Center on Global Climate Change. “State and Local Net Greenhouse Gas Emissions Reduction Programs.” http://www.pewclimate.org/states.cfm?ID=14

Kelley Eichner, Lynne, City of Eugene. “Re: Eugene’s measures.” E-mail to Shanda LeVan. 8 March 2005.ebsite. Accessed 7 March 2005. y of WAshington ing about 1,000 years ago the second and their warmest years. s, and other real

Mitsch, William. “Carbon sequestration, climate change and wetland restoration.” Ohio State University. http://www.aswm.org/science/carbon/quebec/sym27.html

Natural Resource Defense Council. “How Smart Growth Solves Sprawl” http://www.nrdc.org/cities/smartGrowth/solslide/solslide4.asp

Natural Resources Canada. 20 October 2004. “Meeting Climate Change Challenges Through Energy Efficiency”. http://oee.nrcan.gc.ca/publications/infosource/pub/ici/eii/M27-01-1035E.cfm

New York City Department of Transportation. “DOT Alternative Fuels Program.” http://www.nyc.gov/html/dot/html/motorist/alternativefuel.html

Patterson, Jim, Chekay, Doug, and Allen Tyrchniewicz, “Conclusions and recommendations for the Wetland's International study concerning wetlands and climate change and Canadian workshops.” International Institute for Sustainable Development, Winnipeg, Manitoba, Canada. http://www.aswm.org/science/carbon/quebec/sym27.html

Portland's Greenbuilding Resource. "Commercial Building Case Studies." http://www.green-rated.org/cs_list.asp?md=commercial

Program for Watershed and Community Health. Lane County Sustainable Business and Jobs: Preliminary List of Existing Firms and Potential Opportunities for the Southern Willamette Valley. Accessed 26 February 2003. http://cwch.uoregon.edu/ReportsFolder/Existing_Business_and_Emerging_Trends_for_Lane_County_2.26.2003.pdf

Seattle's Office of Sustainability and Environment. "What are the air quality issues in Seattle in 2004?" 1995-2005. http://www.seattle.gov/environment/clean_air.htm#greenFleet

The City of Fort Collins Energy Management Team "City of Fort Collins 2001/2002 Climate Protection Status Report." . August 2003. http://www.uoregon.edu/~bdoppelt/PPPM401_601/fcgov_cp_status_report.pdf

U.S. Department of Energy. Energy Efficiency and Renewable Energy: Green Power. "Green Pricing." 2004. http://www.eere.energy.gov/greenpower/markets/pricing.shtml

U.S. Environmental Protection Agency. "Residential Energy Efficiency Program for Low-Income Multifamily Housing." http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/RAMR5CYQWT/$File/VT_REEP.pdf

U.S. Environmental Protection Agency. "Green Building." 15 December 2004. http://www.epa.gov/oaintrnt/facilities/seattle.htm

University of Florida. "Tomorrow's Energy Today for Cities and Counties: Using Landfill Gas for Energy: Projects that Pay." IFAS Extension. http://edis.ifas.ufl.edu/EH275

University of Oregon. "Lillis Business Complex." http://libweb.uoregon.edu/guides/architecture/oregon/lillis.html

University of Oregon. "Mobile Equipment Shop." 2003. http://facilities.uoregon.edu/mobile.php

West Eugene Wetlands Mitigation Bank. (Online). March, 1 2005. http://www.ci.eugene.or.us/parks/wetlands/

Wetlands and Carbon Sequestration Workshop. (Online). March, 1 2005. http://www.iisd.org/wetlands/workshops.htm

Wylynko, David. "Prarie Wetlands and Carbon Sequestration: Assessing Sinks Under the Kyoto Protocol." International Institute for Sustainable Development, Wetlands International, Ducks Unlimited. Inc. Sept. 1999. http://www.iisd.org/wetlands/wrkshp_summ.pdf

Appendix A: Frequently Asked Questions (FAQ) About Global Warming and Abrupt Climate Change

Q: *What Causes Global Warming and Abrupt Climate Change*?

Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Without this natural "greenhouse effect," temperatures would be much cooler than they are today and life as we know it today on Earth would not be possible. However, scientists believe that humans have exacerbated the greenhouse effect by introducing unnatural levels of greenhouse gases into the atmosphere, thus raising the temperature above normal variations.

Q. *What Does the Term 'Abrupt Climate Change' Mean*?

Many scientists now believe that the unprecedented accumulation of greenhouse gases in the atmosphere may push natural processes beyond a threshold and generate dramatic changes in temperature, precipitation, snowpack, sea levels, marine ecosystems, terrestrial and freshwater ecosystems within a matter of just a few years or decades. 'Abrupt climate change' describes the speed by which climatic shifts appear to be occurring today.

Q. *What Are The Major Sources Of Greenhouse Gases*?

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases.

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned. Coal-burning power plants are the largest U.S. source of carbon dioxide pollution. Automobiles are the second largest source.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock.

Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels. Very powerful greenhouse gases that are not naturally occurring include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), which are generated in a variety of industrial processes.

Q. *What Is Known About Global Warming And Climate Change*?

A broad scientific consensus exists at the international, national, and regional levels that human activities are changing the composition and function of Earth's atmosphere. Increasing levels of greenhouse gases, such as carbon dioxide (CO_2), in the atmosphere since pre-industrial times have been well documented. The scientific consensus is that this atmospheric buildup of carbon dioxide and other greenhouse gases is largely the result of human activities.

The Intergovernmental Panel on Climate Change (IPCC) stated there was a "discernible" human influence on climate; and that the observed warming trend is "unlikely to be entirely natural in origin." In the most recent Third Assessment Report (2001), IPCC wrote "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities." In sum, scientists believe rising levels of greenhouse gases in the atmosphere are contributing to global warming but the exact degree and the ultimate outcomes are difficult to determine at the present time.

Greenhouse gases trap heat in the Earth's atmosphere and tend to warm the planet. By increasing the levels of greenhouse gases in the atmosphere, human activities are strengthening Earth's natural greenhouse effect. Although local temperatures fluctuate naturally, over the past 50 years the average global temperature has increased at the fastest rate in recorded history. The trend is accelerating; the three hottest years on record have all occurred since 1998. The key greenhouse gases emitted by human activities remain in the atmosphere for periods ranging from decades to centuries. This is because greenhouse gasses accumulate quickly but dissipate in the atmosphere very slowly.

At the 2005 annual meeting of the American Association for the Advancement of Science, Tim Barnett of Scripps Institution of Oceanography reported current research findings that provide comprehensive evidence of human induced warming of the world's oceans (Barnett 2005). Using climate models, Barnett and his research team showed that ocean temperatures increased as carbon dioxide emissions increased. The researchers said that the implications of this are vast and that even if changes in emissions are made immediately, water shortages, melting glaciers, and other crises will occur in the next twenty years throughout parts of the world. "Heat and energy levels as deep as nearly a half-mile in some oceans have risen dramatically over the past 40 years, in direct conjunction with rising levels of carbon dioxide and other greenhouse gases." Using new computer models and field tests, these scientists said they have been able to "screen out the effects of naturally occurring phenomena such as historic weather patterns and solar and volcanic activity, which some skeptics have said are more to blame than greenhouse gas emissions for global warming."

In the fall of 2004 a group of 49 scientists from throughout the Pacific Northwest signed a document entitled "Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest." The consensus statement was produced by the Oregon State University Institute for Natural Resources. It states that, "Scientists are very certain that the Pacific Northwest is warming. The SSGCRP Report indicates that the average annual temperature has increased 1-3^{o} F (0.6-1.7^{o} C) over most of the region in the last century. Model simulations suggest that the earlier warming was largely due to natural causes, whereas the most recent warming is best explained by human-caused changes in greenhouse gases. Since 1920, nearly every temperature monitoring station in the Pacific Northwest---both urban and rural—shows a warming trend."

The OSU scientific consensus statement on climate change describes the following impacts from global warming seen in recent decades:

- Temperature: A warming trend of about 1°F has been recorded since the late 19th century. Warming has occurred in both the northern and southern hemispheres, and over the oceans. Confirmation of 20th-century global warming is further substantiated by melting glaciers, decreased snow cover in the northern hemisphere and even warming below ground.

- Precipitation: Since the beginning of the 20th century, average annual precipitation has increased across the Pacific Northwest by 10% with increases of 30-40% in eastern Washington and northern Idaho.

- Sea Level: Land on the central and northern Oregon coast (from Florence to Astoria) is being submerged by rising sea level at an average rate of 0.06 to 0.08 inches annually, as inferred from data for the period 1930-1995.

- Snowpack: Between 1950 and 2000, the April 1 snowpack declined. In the Cascades, the cumulative downward trend in snow-water equivalent is approximately 50 percent for the period 1950-1995. Timing of the peak snowpack has moved earlier in the year, increasing March streamflows and reducing June streamflows. Snowpack at low-to-mid elevations is the most sensitive to warming temperatures.

Q. *What Is Likely But Not Certain About Global Warming And Abrupt Climate Change*?

As atmospheric levels of greenhouse gases continue to rise, scientists estimate average global temperatures will continue to rise as a result. By how much and how fast remain uncertain. IPCC projects further global warming of 2.2-10°F (1.4-5.8°C) by the year 2100. This range results from uncertainties in greenhouse gas emissions, the possible cooling effects of atmospheric particles such as sulfates, and the climate's response to changes in the atmosphere.
The IPCC states that even the low end of this warming projection "would probably be greater than any seen in the last 10,000 years, but the actual annual to decadal changes would include considerable natural variability."

The Oregon State University scientific consensus statement on climate change described the following impacts that could be witnessed in next 10-50 years in the Pacific Northwest:

- Temperature: Temperatures in the Pacific Northwest are expected to continue to increase in response to global climate change. Assessments suggest that the average warming will be approximately 2.7°F by 2030 and 5.4°F by 2050. These projected increases are likely to result in a higher elevation treeline, longer growing seasons, longer fire seasons, earlier animal and plant breeding, longer and more intense allergy season and changes in vegetation zones.

- Precipitation: Oregon is expected to remain a wintertime-dominant precipitation regime (i.e. most precipitation will continue to occur in the winter). In addition, most precipitation will continue to occur in the mountains. Impacts on water resources due to low summer precipitation and earlier peak streamflow will likely include decreased summer water availability, changes in our ability to manage flood damage, shifts in hydropower production from summer to winter, and decreased water quality due to higher temperatures, increased salinity and pollutant concentration.

- Sea Level: Sea level is very certain to continue to rise although the impact will vary depending upon how fast the land is rising. In addition to increases in sea level, maximum wave heights will likely also increase, resulting in increasing erosion in coastal areas.

- Snowpack: April 1 snowpack will continue to decline corresponding to an earlier peak streamflow.

- Marine Ecosystems: It is very certain that ocean circulation will continue to change in response to ocean-atmosphere processes. These changes suggest a likely increase in the magnitude and duration of upwelling, which will affect marine ecosystems. It is uncertain whether these changes will have adverse impacts such as more frequent occurrences of the low-oxygen events seen in 2002 and 2004.

- Terrestrial Ecosystems: The impact of changes in temperature and precipitation on terrestrial ecosystems is poorly known. Due to current biomass densities, the anticipated drier summers will likely increase drought stress and vulnerability of forests to insects, disease, and fire.

Q. *What Remains Uncertain About Global Warming And Abrupt Climate Change*?

Scientists have identified that human health, agriculture, water resources, forests, wildlife and coastal areas are most vulnerable, at least initially, to the changes that global warming may bring. But projecting the exact local impacts over the 21st century remains very difficult. Scientists are more confident about their projections for large-scale areas (e.g., global temperature and precipitation change across Pacific rim, average sea level rise) and less confident about the ones for small-scale areas (e.g., regional and local temperature and precipitation changes, altered weather patterns, soil moisture changes). This is largely because the computer models used to forecast global climate change are still not capable of simulating how things may change at smaller scales.

Some of the largest uncertainties are associated with events that pose the greatest risk to human societies. The IPCC cautions, "Complex systems, such as the climate system, can respond in non-linear ways and produce surprises." There is the possibility that a warmer world could lead to more frequent and intense storms, including hurricanes. Preliminary evidence suggests that, once hurricanes do form, they will be stronger if the oceans are warmer due to global warming. However, the jury is still out whether or not hurricanes and other storms will become more frequent.

More and more attention is being aimed at the possible link between El Niño events – the periodic warming of the equatorial Pacific Ocean – and global warming. Scientists are concerned that the accumulation of greenhouse gases could inject enough heat into Pacific Ocean waters such that El Niño events become more frequent and fierce. Here too, research has not advanced far enough to provide conclusive statements about how global warming will affect El Niño.

Precipitation changes are also uncertain. The challenge will be to resolve scientific uncertainties about the interactions among atmosphere, land and ocean before significant climate change impacts occur.

Q. *What About The Contrarian Views On Global Warming*?

Over the years, some scientists have challenged the idea that global warming is occurring or, if it is, can be attributed to anthropogenic (human-caused) sources. Most scientists agree that surface temperatures have increased, but some disagree on the cause of the increase in temperature. According to a New York Times article published on January 29, 2000 entitled "Global Warming: The Contrarian View", some scientists believe that the observed surface warming of about one degree over the last century, with an especially sharp rise in the last quarter century, is mostly or wholly natural, and that there is no significant human influence on global climate. These same scientists also believe that any future warming will be "inconsequential or modest at most, and that its effects will largely be beneficial."

Skeptics of climate change question the accuracy of climate models and other methods used to measure temperature patterns. Some scientists also criticize how and where climate change data is collected. About a decade ago, scientists based their assessment that the earth's temperature was rising on a single set of observations, those at the planet's surface. But some scientists pointed out that surface temperature readings are subject to multiple kinds of distortion, such as heat emitted by the concrete of cities. Consequently, scientists began measuring earth temperatures with satellites. Both sets of data (surface and satellite) found substantial warming over Northern Hemisphere continents at the same time of year, but the satellites didn't show a warming trend for up to about five miles from the surface of the planet. In fact, these measurements showed a cooling trend. Over time the satellite measurements have been improved to filter out the effects of natural, short-term climate fluctuations, such as El Nino, and eliminate other distortions caused by the movement of the satellites. After correcting these problems, the satellites now reveal a general warming trend, but slightly less than the surface record. Because there is a margin of error in using both surface and satellite measuring devices, it's difficult to determine if the difference in temperature is attributable to the error itself or actual differences in temperature data. The computer models used to simulate future impacts of climate change are imperfect and should be used cautiously.

Steven Schneider, a leading climate scientist at Stanford University, feels strongly that the numerous data sets and analyses on climate change are accurate, and that humans are responsible for the changes we have witnessed. In his testimony on July 10, 1997 at Stanford University, Schneider stated that "current estimate of climate sensitivity is not off by a factor of ten, as some 'contrarians' assert." Climate models are able to measure seasonal variation very well, even though the models might be off by five or six degrees. What the models are good at is measuring the amplitude of surface air temperature change. Schneider states that "If we were making a factor of ten error by either overestimating or underestimating the sensitivity of the climate to radiative forcing, it would be difficult for the models to reproduce the different seasonal cycle surface temperature amplitudes over land and oceans as well as they do. Indirect evidence like ice ages, volcanic eruptions and the seasonal cycle simulation skills of models are prime reasons why many of us in the scientific community have for the past twenty years expected that 'demonstrable' anthropogenic climate change was not unlikely by the 21st century…In my opinion it is unlikely that natural variability is the explanation of all climate change, especially that which has been documented in the 20th century."

Schneider's views have been supported by the Intergovernmental Panel on Climate Change (IPCC), which includes hundreds of scientists from all regions of the world (IPCC 2001) and by the consensus statement on climate change produced by the Oregon State University Institute for Natural Resources that was signed by 49 Northwest scientists in the fall of 2004. These scientific bodies underscore that a strong international consensus exists that global warming and abrupt climate change are occurring and are due to, or at least exacerbated by human activities.

Q. *Do Global Warming And Abrupt Climate Change Produce Any Benefits*?

In the short run, some regions of the country and some economic sectors may benefit by increased warming. However, the interdependence of natural ecological and human economic systems suggest there is no free lunch—if some regions or sectors benefit others are likely to be harmed. For example, warmer temperatures may, in the short term, benefit Oregon residents who a milder climate. Farmers who can quickly shift to crops adapted to earlier growing seasons, higher temperatures, and less precipitation may benefit. At the same time, some parts of the country may become less desirable due to excess heat or lack of water, which may trigger migration to areas that appear more habitable, such as the Northwest and Oregon. Increased population densities may place further strain on resources. New entrants into already crowded agricultural markets could lead to oversupply and thus depressed prices, thus harming all farmers. The long-term effects are even less certain. For example, if warm dry patterns continue, industries dependent on ample supplies of clean water, such as high tech, may be forced to move to areas that can provide inexpensive steady supplies of water.

More importantly, the climate is changing much faster than scientists first predicted—thus the term abrupt climate change-- and much faster than evolution. Historically, temperature variations have occurred on Earth. However, most of these changes evolved over hundreds or thousands of years, giving plant and animal species and humans ample time to adapt. By comparison, today's changes are occurring so rapidly that many plants, animals, and humans may struggle to adapt. This could mean that in the long run every region of the nation and every economic sector may experience discontinuous change. Further, no one really knows how the global or regional climates will change--all that is certain is that what we thought to be the normal relatively even-state climatic patterns are a thing of the past and greater variance and extremes are likely. This means the “benefits” produced in the immediate future may be dwarfed in relatively short order by unpleasant events as greenhouse gases continue to accumulate and warming increases.

Q. *Could A Proactive Response to Climate Change Be Beneficial?*

The broad scientific consensus that the Earth is warming suggests that at basic level it does not matter if human or natural processes are the cause. The fact is warming is occurring. This reality suggests that it may be prudent to plan responses now while a window of opportunity remains open. Reducing greenhouse gas emissions and developing adaptation plans could be thought of as ways to “hedge our bets” and prepare for the future, not matter what the causes of the warming may be.

The exciting news is that a growing stream of research shows that currently available, cost effective technologies and practices exist that cut the pollution causing global warming while at the same time reducing costs for energy, water, and raw materials, increasing efficiency and productivity, and generating whole new industries and jobs in fields such as energy efficiency, renewable energy and green building. Thus, climate protection plans can help communities meet existing goals and improve livability.

Q. How Can We Reduce Global Warming Pollution?

State and local governments, private businesses, non-profits and households can help reduce the effects of global warming and abrupt climate change by developing climate protection plans. These plans would include greenhouse gas reduction (mitigation) and adaptation components. Greenhouse gas reduction plans are key because it is important to ensure that we reduce the quantity of emissions society emits into the atmosphere. This can be achieved by increasing energy efficiency in buildings and transportation, maximizing our use of efficient and “cleaner” technologies; increasing our reliance on renewable energy sources such as wind, sun, biofuels, and geothermal; and other steps.

Appendix B: Drinking Water Sources, Estuaries, and Climate Change In Lane County

Cities within Lane County obtain their drinking water from wells or from rivers, or from a combination of both. This section describes the source of Lane County's drinking water, and where possible, the potential affects climate change can have on drinking water sources.

Summary

When cities use surface water as a drinking water source, there is a chance that a flooding event could contaminate the system with sediment, making the water more difficult to filter, and thus increasing the need to add more chemicals to treat the water. However, most water utilities don't raise their cost to consumers during these flood events. I would hypothesize that because many of these events are short-term, there is no need to increase the costs. Flooding also has the potential to contaminate wells, as many of them are not sealed at depths greater than 30 feet. The permeability of the soil and high ground water table can allow materials to flow in and out of the wells. Flooding can also contaminate rivers and aquifers, the recharging source for many wells.

Flooding is typically characteristic of carrying an abundance of water, which increases erosion and sedimentation at it scours the banks of rivers and topsoil. Increased sedimentation and water pollution can also result from too little water. If climate change creates a temperature rise, and increased drought in the summer, water pollutants will become more concentrated in these drinking water sources. As a result, cities may have to seek alternative sources of water as it becomes increasingly difficult to treat the water.

Water use is typically less in the winter than in the summer, because we tend to water our lawns heavily in the summer. Consequently, several cities use close to, if not all, of their wells to supply their residents with water in the summer. Relatively few wells are operated in the winter months. Some utility companies charge more for water during the summer months to "punish" people who use water unwisely during the scarcest time of year. Other water suppliers have a tiered energy rate; the more you use, the more you pay, all year long. If climate change makes water more scarce during particular times of the year, water companies may have to charge more to their costumers, including residential, commercial, and industry. Water companies may also be forced to drill more wells as the population increases and demand grows for water. The cost to drill a well isn't cheap. To make up for these costs, there is the potential for water companies to charge them for these services.

Alderwood Water Development Company

The drinking water for Alderwood Water Development Company (Alderwood) is supplied by an intake on Woahink Lake. The intake is located in the Woahink River/Siltcoos Riber/Tahkenitch Lake Frontal Watershed in the Siltcoos Sub-Basin of the Northern Oregon Coastal Basin. The geographic area providing water to Alderwood's intake (the drinking water protection area) includes approximately 1.18 miles of streams and 75.8 acres of lakes. The protection area comprises a total area of 6.7 square miles. This public water system serves approximately 35 citizens.

A total of twenty-three potential contaminant sources were identified in the drinking water protection area. Ten of these are located in sensitive areas and nine are high- to moderate-risk sources within "sensitive areas". The sensitive areas within the drinking water protection area include areas with high soil erosion potential, high runoff potential and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Water Assessment Summary Brochure. Alderwood Water Development Company. Department of Environmental Quality. PWS # 4100304, Feb. 2003.
http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00304_Alderwood.pdf)

Cottage Grove

The City of Cottage Grove is supplied by surface water intakes located on Row River, Prather Creek, and Laying Creeks and by a supplemental groundwater well. Cottage Grove withdraws water from the Dorena Reservoir on the Row River. The reservoir is located in the Umpqua Forest in the Coast Fork Willamette Basin. Water is withdrawn above the reservoir at Laying Creek, which is the tributary/headwater to the Row River. Cottage Grove also diverts water from the Row River into the Salt River before it merges into the Coast fork of the Willamette River. The intakes are located in the Lowe Row River and Laying Creek Watersheds of the Coast Fork Willamette Sub-Basin of the Willamette Basin. The streams that contribute to the intakes extend upstream a cumulative total area of approximately 34 miles and encompass a total area of approximately 371 square miles. This public water system serves approximately 8,500 citizens.

A total of 45 potential contaminant sources were identified in the drinking water protection area. All of these are located in the sensitive areas and 43 are high- to moderate- risk sources within "sensitive areas". The sensitive areas within the City of Cottage Grove's drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Telephone Interview. Ray at the City of Cottage Grove. 31 Jan. 2005. Water Assessment Summary Brochure. City of Cottage Grove. Department of Environmental Quality. PWS # 4100236, Feb. 2003.
http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00236_CottageGrove.pdf)

Creswell

The drinking water for the City of Creswell is supplied by a surface water intake on the Coast Fork Willamette River and by multiple groundwater wells. The surface water intake is located in the Lower Coast Fork Willamette River/Upper Coast Fork Willamette River Watershed in the Coast Fork Willamette Sub-Basin of the Willamette Basin. The drinking water intake for the City of Cottage Grove and London Water Co-op public water systems are located upstream of the Creswell intake. In addition, there are three drinking water intakes downstream of Creswell's intake including the intakes for Pope and Talbot Inc., the City of Corvallis, and Adair Village Water System which all have their intakes on the Willamette River. Consequently, activities and impact in the Creswell drinking water protection area have the potential to also impact downstream users. The public water system serves approximately 3,380 citizens.

The geographic area providing water to Creswell's intake extends upstream approximately 208 miles in a southerly direction and encompasses a total area of 192 square miles. Included in this area are a number of tributaries to the main stem, including the Row River and its tributaries, Gettings, Lynx Hollow, Sink, Martin, Williams, Wilson, Cedar, and Saroute Creeks as well as numerous smaller tributaries.

A total of 50 potential contaminant sources were identified in the City's of Creswell's drinking water protection area. All of these are located in the sensitive areas and 49 are high- to moderate-risk sources within "sensitive areas". The sensitive areas within the drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Source Water Assessment Summary Brochure. City of Creswell. Department of Environmental Quality. PWS # 4100246, Feb. 2003.
http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00246_Creswell.pdf)

Drain

The drinking water for the City of Drain is supplied by intakes on Bear Creek (Whipple Reservoir) and Alan Creeks. The intakes are located in the Elk Creek/Umpqua River Watershed in the Umpqua Sub-Basin of the Southern Oregon Coastal Basin. The streams that contribute to the Bear Creek and Alan Creek intakes extend upstream a cumulative total of approximately 8.1 miles and encompass a total area of approximately 6.2 square miles. The combination of the geographic areas contributing to the Bear Creek and Alan Creek intakes make up Drain's drinking water protection area. The public water system serves approximately 1,145 citizens.

A total of six potential contaminant sources were identified in the drinking water protection area. All of these are located in the sensitive areas and five are high- to moderate risk sources within "sensitive areas." The sensitive areas within the drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Source Water Assessment Summary Brochure. City of Drain. Department of Environmental Quality. PWS # 4100260. Feb. 2003. http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00260_Drain.pdf)

Eugene

Eugene's Water and Electric Board (EWEB) withdrawals water from the McKenzie River at Haden Bridge for Eugene's drinking water. In the winter the City withdraws 20 million gal/day, and in the summer 40 million gal/day. Summer demand is greatest, because this is the time when most people water their lawns. The plant's capacity is 70 million gal/day, but to meet future growth demands, the City is proposing to drill wells in an aquifer north of Eugene. The price consumers have to pay for their water varies by the size of the meter and line and elevation. Consequently, people living in the South Hills of Eugene can expect to pay more for water than people on the valley floor, because water has to be pumped uphill. You can also expect to pay more if you use more. EWEB's tiered rate ensures that the more water you use, the more you pay. The average cost to consumers is $1.70 per 1000 gallons of water.

Climate change is expected to increase the severity and amount of flooding throughout the Pacific Northwest. While EWEB has a filtering plant, the 1996 flood made water more difficult to treat due to increased sedimentation. They had to add a lot of chemicals to maintain water quality, which also affects the taste of the water, but they never increased the price of water to the consumer. As a comparison, Salem's water utility treatment plant had to shut down due to high sediment loads. The high sediment loads Salem experiences was partly due to the loss of forest land upstream of their water source. It is assumed that very little change would occur to Eugene's drinking water system in the event of climate change, because the McKenzie River is fed by snow and rain, and is large enough to absorb some of the impacts.

(Telephone interview. John Semal at Eugene's Water and Electric Board, 31 Jan. 2005)

Florence

Florence's drinking water comes from seven dunal wells located on eighty acres of city owned land behind the water filtration plant at 2450 Willow Street. After the water is treated and filtered it is stored in reservoirs at two locations. The total capacity is 4,500,000 gallons. The reservoirs include two 2,000,000 gallon tanks located north of 35th Street, west of Hwy 101, and a 5,000,000 gallon tank located on 31st Street. During periods of high water demand, typically between Memorial Day and Labor Day, the City supplements their water supply by purchasing additional water from Heceta Water district, which gets its water from Clear Lake, north of Munsel Lake Road. The city serves approximately 3500 customers. The current well field is fully utilized, so the city is in the process of adding five new wells and three more filters. This will increase the capacity approximately 1,800,000 gallons.

The aquifer supplying drinking water to the City's wells is considered to be shallow and unconfined. The aquifer is considered highly sensitive to contamination because of the shallow unconfined nature of the aquifer, the highly permeable geologic material separating the aquifer from the surface, the high infiltration potential that exists for the aquifer and the past detection of toluene and chloromethane in the water supplied by the aquifer. Groundwater occurs at depths ranging from 13 to 70 feet below the surface. The presence of highly permeable soils within the

DWPA, the high number of other wells in proximity to the wellfield and the age of two of the wells also contribute to the overall sensitivity of the drinking water. Storm water outfalls is a potential source of contamination to the wells within a five and ten year time frame; however, this is rink is low compared to other sources of contaminants on the site. It was also found that their drinking water supply is susceptible to viral contamination.

(Source: City of Florence 2002 Water Quality Report. June 2003. http://www.ci.florence.or.us/downloads/2002wqr.pdf)

Heceta Water District

The drinking water supply for Heceta Water District is supplied by an intake on Clear Lake. The intake is located in the Lower Siuslaw River Watershed in the Siuslaw Sub-Basin of the Northern Oregon Coastal Basin. The geographic area providing water to Heceta Water District's intake includes 149.6 acres of lakes (including Munsel Lake, Clear Lake, Ackerley Lake and Collard Lakes) and 0.23 miles of streams. The protection area encompasses a total area of 0.96 square miles. Heceta's Water District serves approximately 4,500 citizens.

Two potential contaminant sources were identified in Heceta Water District's drinking water protection area. Both are located in the sensitive areas and are high- to moderate-risk sources within "sensitive areas". The sensitive areas within the drinking water protection area include areas with high soil permeability and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Source Water Assessment Summary Brochure. Heceta Water District. Department of Environmental Quality. PWS # 4100301, Feb. 2003. http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00301_Heceta.pdf)

Junction City

Unlike Cottage Grove and Eugene, Junction City gets its drinking water from wells. There are a total of six wells that supply the city with drinking water. Two of these are used in the fall/winter, and four of the six are used in the summer. The number of wells needed is of course based on demand, so as the population grows they anticipate having to drill more wells. The average cost to drill a well is about $400,000.

The central feature of the regional drainage system is the Willamette River, but the City itself is located between the Willamette River and the Long Tom River. The water table in the vicinity of Junction City is generally within 20 feet of the land surface at most times of the year and extends above the ground surface in some local areas, particularly in winter along the minor streams.

(Telephone interview. Public Works department in Junction City. 31 Jan. 2005 Junction City Drinking Water Protection Plan. Developed by the Junction City Drinking Water Protection Committee in cooperative efforts with OHD, DEQ, and ODA assistance. Lane Council of Governments. 1998).

London Water Co-op

Drinking water for the co-op is supplied by an intake on Beaver Creek. The intake is located in the Upper Coast Fork Willamette Watershed in the Coast Fork Willamette Sub-Basin of the Willamette Basin. The geographic area providing water to London Water Co-op's intake extends upstream 1.6 miles in a northwesterly direction and encompasses a total area of 1.35 square miles. This drinking water supply serves approximately 50 citizens.

A total of four potential contaminant sources were identified in the drinking water protection area. All of the areas are located in sensitive areas and are high- to moderate-risk sources within "sensitive areas". The sensitive areas within the drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Source Water Assessment Summary Brochure. London Water Co-op. Department of Environmental Quality. PWS # 4100239, Feb. 2003. http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00239_LondonCoop.pdf)

Mapleton Water District

The drinking water for the Mapleton Water District is supplied by an intake on Bershire Creek. The intake is located in the Lower Siuslaw River Watershed in the Siuslaw Sub-Basin of the Northern Oregon Coastal Basin. The geographic area providing water to the district's intake extends upstream approximately 2.5 miles in a westerly to southwesterly direction and encompasses a total area of 0.78 square miles. The water system serves approximately 750 citizens.

Sensitive areas identified in the Mapleton Water District watershed include primarily the areas within the 1000' setback from the streams. Currently, there are no potential contaminant sources located within the sensitive areas.

(Source Water Assessment Summary Brochure. Mapleton Water District. Department of Environmental Quality. PWS # 4100507, Feb. 2003. http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00507_Mapleton.pdf)

South Coast Water District

South Coast's water is supplied by an intake on the Siltcoos Lake. The intake is located in the Woahink River/Wiltcoos River/Tahenitch Lake Frontal Watershed in the Silcoos Sub-Basin of the Northern Oregon Coastal Basin. The geographic area proving water to the water intake extends upstream approximately 85 miles in an easterly direction and encompasses a total area of 61.8 square miles. The public water system serves approximately 125 citizens.

A total of nineteen potential contaminant sources were identified in South Coast Water District's water protection area. Seventeen of these are located in the sensitive areas and fourteen are high- to moderate-risk sources within "sensitive areas". The sensitive areas within the drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Source Water Assessment Summary Brochure. South Coast Water District. Department of Environmental Quality. PWS # 4100302, Feb. 2003. http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00302_SouthCoast.pdf)

Springfield

The City of Springfield relies on both wells and surface water from the Mid Willamette Fork. There are a total of 32 wells that are shared between the Springfield Utility Board (SUB) and Rainbow Electric. SUB supplies water to residents within the City limits, and Rainbow electric provides water to residents with a Springfield address outside of the City limits. All 32 wells are in use during the summer, but only 20 are used in the in winter. The water withdrawn from the Mid Willamette Fork is only used in the summer, because wells are a cleaner source of drinking water. The capacity of the wells is 25.23 million gal/day. The treatment facility withdraws 6.6 million gal/day with a peak of 10 million gal/day. Due to water rights, the City is only allowed to withdraw 10 million gal/day from the Willamette.

Residents in Springfield pay more for their water in the summer than winter, but only if you stay within a certain range of water usage. Unlike Eugene, Springfield residents pay more for using less water, with the exception of the additional fee charged in the summer. The average price a consumer pays varies widely depending on their location.

As a precaution, the City turned off some of the wells during the 1996 flood that were adjacent to the McKenzie River, but the Mid Willamette Fork supply of drinking water was not affected.

(Telephone interview. Chuck Davis at the Springfield Utility Board (SUB). 2 Feb. 2005).

Veneta

Veneta has nine wells but only operates on two. The aquifer that supplies the wells consists of sand and gravel. The alluvial deposits that supply the City's water lies below approximately 40 feet of silt and clay. The water level when the well is not being pumped is about 50-70 feet in the late summer, and approximately 30 feet in the spring. The presence of shallow water in the winter, often at depths of less than 10 feet, makes the aquifer vulnerable to contamination during this period of time. There is concern that the shallow water will gain access into the acquifer that supplies Veneta's drinking water. Most of the wells are sealed to less than 25 feet, and most of those to less than 20 feet. These wells, which technically meet well construction standards, do allow shallow water to gain access to the casing and potentially migrate down to the acquifer. It is hypothesized that wells with seals less than 30 feet may be susceptible to the impacts of this shallow water. The two wells Veneta relies on are sealed to 30 feet and 19 feet. The water protection area is located within the upper Willamette River basin in west-central Oregon between the Coast and Cascade Ranges.

(Telephone interview. Veneta Water Treatment Plant. 31 Jan. 2005. Source Water Assessment Report. City of Veneta. Department of Human Services, Oregon Health Division, Drinking Water Program, and the Department of Environmental Quality Drinking Water Protection Program. PWS # 4100920, Feb. 2000. http://www.deq.state.or.us/wq/dwp/VenetaSWA.pdf)

Westfir

The drinking water for Westfir is supplied by an intake on the North Fork of Middle Fork of the Willamette River. The intake is located in the Upper and Lower North Fork of the Middle Fork Willamette Watershed in the Middle Fork Willamette Sub-Basin of the Willamette Basin. The geographic area providing water to the City's intake extends upstream 347 miles in a westerly direction and encompasses a total area of 243 square miles. The drinking water system serves approximately 330 citizens.

A total of sixteen potential contaminant sources were identified. All of these are located in the sensitive areas and fourteen are high- to moderate-risk sources within "sensitive areas". The sensitive areas within the drinking water protection area include areas with high soil erosion potential, high runoff potential and areas within 1000' from the rivers/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.

(Source Water Assessment Summary Brochure. City of Westfir. Department of Environmental Quality. PWS # 4100939, Feb. 2003.
http://www.deq.state.or.us/wq/dwp/SWAReports/PWS00939_Westfir.pdf)

Estuaries in Lane County

Ten mile Creek	- Natural	- 35 acres
Big creek	- Natural	- 35 acres
Berry Creek	- Natural	- 30 acres
Silt Coos River	- Natural	- 45 acres
Sutton River	- Natural	- 45 acres
Siuslaw river	- shallow draft development	- 2245 acres

Siuslaw – salmon and Cutthroat trout Rearing migration habitat (18 deg C)

Appendix C: Data Sheets Provided by the City of Eugene

	2004					2003			2002		
	total units		total cost		% green power	total units	total cost	% green power	total units	total cost	% green power
Buildings											
Electricity (kWh)	18,142,846		$ 1,160,426			19,094,653	$ 1,088,793		17,678,898	$ 1,055,974	
Natural Gas (therms)	397,589		$ 336,748		--	442,201	$ 329,210	--	429,798	$ 339,628	--
Propane	0		$ -		--	-	$ -	--	-	$ -	--
Fuel Oil (gals)	-		$ -		--	-	$ -	--	-	$ -	--
Steam (klbs)	10,462		$ 198,003		--	11,306	$ 181,419	--	14,475	$ 221,479	--
Total square footage	2,283,032		--		--	2,290,735	--	--	2,178,734	--	--
Number of municipal employees	1,451		--		--	1,475	--	--	1,467	--	--
Lighting											
Street Lights - Electricity (kWh)											
Traffic Signals - Electricity (kWh)											
Park Lighting (kwh)	337,589		$ 31,529			308,272	$ 27,938		289,699	$ 25,930	
Number of street lights (by type)			--		--		--	--		--	--
Number of traffic signals			--		--		--	--		--	--
Fleets											
Unleaded gasoline (gal)	220,841	58%	$ 333,430	62%	--	219,248	$ 271,817	--	204,337	$ 225,350	--
Diesel (gal)					--	158,038	$ 164,400	--	147,290	$ 136,296	--
BioDiesel (gal)	159,187	42%	$ 201,665	38%							
Propane (GGE)					--			--			--
Compressed Natural Gas CNG (GGE)					--			--			--
Total Combined	380,028		$ 535,095			377,286	$ 436,217	--	351,627	$ 361,646	--
Wastewater Treatment											
Electricity (kWh)	10,568,688		$ 605,825			9,704,746	$ 592,592		8,687,341	$ 323,416	
Natural Gas (ccf)	12,778		$ 12,341			12,604	$ 10,783		12,401	$ 10,716	
Solid Waste (generated from internal operations)											
Total Waste removed (tons)	1,606		97,083.24		--			--			--
Estimate of composition (Percentage of different types of waste)											
Paper & paper products (%)			--		--		--	--	36%	--	--
Food waste (%)			--		--		--	--	22%	--	--
Plant debris (%)			--		--		--	--	5%	--	--
Wood, furniture, textiles (%)			--		--		--	--	5%	--	--
All other waste (%)			--		--		--	--	32%	--	--
									numbers from Alex Cuyler		
(Total Units means KWh, ccf, Gallons etc;									general commercial waste stream		
Green Power means wind, solar)											

	2001				2000				1999		
	total units	total cost	% green power		total units	total cost	% green power		total units	total cost	% green power
Buildings											
Electricity (kWh)	18,155,646	$ 757,339			19,782,658	$ 778,755			20,786,792	$ 794,307	
Natural Gas (therms)	437,918	$ 331,729	--		365,630	$ 230,387	--		404,775	$ 211,618	--
Propane	-	$ -	--		-	$ -	--		-	$ -	--
Fuel Oil (gals)	-	$ -	--		-	$ -	--		156	$ 101	--
Steam (klbs)	14,131	$ 225,408	--		16,052	$ 209,705	--		21,076	$ 222,351	--
Total square footage	2,190,051	--	--		2,178,724	--	--		2,334,764	--	--
Number of municipal employees	1,430	--	--		1,404	--	--		1,388	--	--
Lighting											
Street Lights - Electricity (kWh)											
Traffic Signals - Electricity (kWh)											
Park Lighting (kwh)	260,175	$ 19,078			257,794	$ 16,439			247,518	$ 13,611	
Number of street lights (by type)		--	--			--	--			--	--
Number of traffic signals		--	--			--	--			--	--
Fleets											
Unleaded gasoline (gal)	-	$ 240,625	--		219,540	$ 221,097	--		176,991	$ 154,998	--
Diesel (gal)	-	$ 145,534	--		158,249	$ 133,723	--		127,579	$ 93,746	--
BioDiesel (gal)											
Propane (GGE)			--				--				--
Compressed Natural Gas CNG (GGE)			--				--				--
Total Combined		$ 386,159	--		377,789	$ 354,820	--		304,570	$ 248,744	--
Wastewater Treatment											
Electricity (kWh)	7,517,796	$ 328,851			9,457,960	$ 327,459			11,730,475	$ 358,541	
Natural Gas (ccf)	12,094	$ 10,387			2,596	$ 2,031			0	0	
Solid Waste (generated from internal operations)											
Total Waste removed (tons)	1,855	$ 91,776	--				--				--
Estimate of composition (Percentage of different types of waste)											
Paper & paper products (%)		--	--			--	--			--	--
Food waste (%)		--	--			--	--			--	--
Plant debris (%)		--	--			--	--			--	--
Wood, furniture, textiles (%)		--	--			--	--			--	--
All other waste (%)		--	--			--	--			--	--

(Total Units means KWh, ccf, Gallons etc;
Green Power means wind, solar)

	1998			1997			1996		
	total units	total cost	% green power	total units	total cost	% green power	total units	total cost	% green power
Buildings									
Electricity (kWh)	19,750,341	$ 758,902		20,686,522	$ 825,019		20,617,278	$ 780,469	
Natural Gas (therms)	384,576	$ 184,449	--	370,730	$ 145,085	--	384,587	$ 156,859	--
Propane	-	$ -	--	-		--	-	$ -	--
Fuel Oil (gals)	677	$ 460	--	766	$ 692	--	1,075	$ 986	--
Steam (klbs)	18,551	$ 188,066	--	20,289	$ 234,860	--	23,168	$ 218,924	--
Total square footage	2,107,579	--	--	2,005,262	--	--	2,004,470	--	--
Number of municipal employees	1,338	--	--	1,313	--	--	1,367	--	--
Lighting									
Street Lights - Electricity (kWh)									
Traffic Signals - Electricity (kWh)									
Park Lighting (kwh)	236,240	$ 13,272		245,636	$ 13,713		244,091	$ 13,901	
Number of street lights (by type)		--	--		--	--		--	--
Number of traffic signals		--	--		--	--		--	--
Fleets									
Unleaded gasoline (gal)	N/A	$ 197,051	--	N/A	$ 216,706	--	N/A	N/A	--
Diesel (gal)	N/A	$ 119,180	--	N/A	$ 131,068	--	N/A	N/A	--
BioDiesel (gal)									
Propane (GGE)			--			--			--
Compressed Natural Gas CNG (GGE)			--			--			--
Total Combined	N/A	$ 316,231	--	N/A	$ 347,774	--	N/A	N/A	--
Wastewater Treatment									
Electricity (kWh)	10,250,341	$ 348,644		12,303,799	$ 390,995		13,948,915	$ 444,897	
Natural Gas (ccf)	-	$ -		-	0		-	$ -	
Solid Waste (generated from internal operations)									
Total Waste removed (tons)			--			--			--
Estimate of composition (Percentage of different types of waste)									
Paper & paper products (%)		--	--		--	--		--	--
Food waste (%)		--	--		--	--		--	--
Plant debris (%)		--	--		--	--		--	--
Wood, furniture, textiles (%)		--	--		--	--		--	--
All other waste (%)		--	--		--	--		--	--
(Total Units means KWh, ccf, Gallons etc;									
Green Power means wind, solar)									

	1995				1994		
	total units	total cost	% green power		total units	total cost	% green power
Buildings							
Electricity (kWh)	20,441,109	$ 776,785			20,132,743	$ 764,797	
Natural Gas (therms)	363,268	$ 161,208	--		371,624	$ 177,400	--
Propane	-		--		-	$ -	--
Fuel Oil (gals)	994	$ 937	--		1,399	$ 1,359	--
Steam (klbs)	18,116	$ 178,492	--		19,309	$ 169,582	--
Total square footage	1,910,170	--	--		1,910,170	--	--
Number of municipal employees	1,320	--	--		1,278	--	--
Lighting							
Street Lights - Electricity (kWh)							
Traffic Signals - Electricity (kWh)							
Park Lighting (kwh)	235,186	$ 13,371			232,572	$ 12,843	
Number of street lights (by type)		--	--			--	--
Number of traffic signals		--	--			--	--
Fleets							
Unleaded gasoline (gal)	191,025	$ 175,045	--		189,835	$ 169,940	--
Diesel (gal)	137,695	$ 105,870	--		136,837	$ 102,783	--
BioDiesel (gal)							
Propane (GGE)			--				--
Compressed Natural Gas CNG (GGE)			--				--
Total Combined	328,720	$ 280,915	--		326,672	$ 272,723	
Wastewater Treatment							
Electricity (kWh)	12,734,091	$ 399,358			6,410,007	$ 208,813	
Natural Gas (ccf)	-	$ -			-	$ -	
Solid Waste (generated from internal operations)							
Total Waste removed (tons)			--				--
Estimate of composition (Percentage of different types of waste)							
Paper & paper products (%)		--	--			--	--
Food waste (%)		--	--			--	--
Plant debris (%)		--	--			--	--
Wood, furniture, textiles (%)		--	--			--	--
All other waste (%)		--	--			--	--
(Total Units means KWh, ccf, Gallons etc;							
Green Power means wind, solar)							

Appendix D: Energy Reduction Programs, City of Eugene, 1995-2004.

Project Name	FY of Est Completion	Project Description	Project Type	Est Energy Savings (MBTUs)	Energy Types Saved
Facilities Shop	FY 1995	Upgrade from T-12 to T-8 lighting and add occupancy sensors	Operations and Maintenance Project	44	Electric
Fire Station #4	FY 1995	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	49	Electric
Amazon Pool-Lighting	FY 1996	Improve quality and efficiency of bathhouse and and pool lighting	Operations and Maintenance Project	65	Electric
PWA-1st and 2nd floor	FY 1996	Upgrade from T-12 to T-8 lighting in conjunction with remodel work	CIP Remodel or Renovation	26	Electric
Fire Station #3	FY 1997	Upgrade from T-12 to T-8 lighting in conjunction with remodel work	CIP Remodel or Renovation	45	Electric
Petersen Barn	FY 1997	Upgrade from T-12 to T-8 lighting in conjunction with remodel work	Operations and Maintenance Project	42	Electric
Fire Station #5	FY 1997	Upgrade from incandescents to T-8 lighting	Operations and Maintenance Project	7	Electric, Natural Gas
Overpark Relighting	FY 1998	Perimeter lights on photocell control	CIP Remodel or Renovation	542	Electric
Conference Center	FY 1998	Upgrades to lighting, HVAC, motors. Digital control added	Whole Building Energy Improvement	3150	Electric, Steam
Downtown Mall	FY 1999	Replace incandescent with metal halide under canopies	Operations and Maintenance Project	217	Electric
Echo Hollow Pool	FY 1999	Solar pool heat, heat recovery, digital control, motor and lighting	Whole Building Energy Improvement	3873	Electric, Natural Gas
Sheldon Pool and Center	FY 1999	Solar pool heat, heat recovery, Digital control, motor and lighting upgrades	Whole Building Energy Improvement	8770	Electric, Natural Gas
City Hall-Municipal Court	FY 2000	Upgrade from T-12 to T-8 lighting in conjunction with remodel work	CIP Remodel or Renovation	196	Electric
Hult Center	FY 2000	Replace failing control system for HVAC and lighting	Whole Building Energy Improvement-Phased	759	Electric, Steam
PWA-Whole Building	FY 2000	Add exterior insulation and replace windows on East side	CIP Remodel or Renovation	106	Electric, Steam
FS#7--Lighting upgrade	FY 2000	Upgrade from T-12 to T-8 lighting in conjunction with remodel work	CIP Remodel or Renovation	24	Electric
Campbell Center HVAC	FY 2000	Increase efficiency of new cooling units	CIP Remodel or Renovation	85	Electric
Hilyard Lighting Upgrade	FY 2000	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	65	Electric
City Hall-Records, Briefing and Patrol	FY 2001	Upgrade from T-12 to T-8 in conjunction with remodel work	CIP Remodel or Renovation	255	Electric, Steam, Natural Gas

Project Name	FY of Est Completion	Project Description	Project Type	Est Energy Savings (MBTUs)	Energy Types Saved
Amazon CC Lighting Upgrade	FY 2001	Upgrade from T-12 to T-8 lighting and add occupancy sensors	Operations and Maintenance Project	119	Electric
Amazon Pool Remodel	FY 2001	Add solar pool heating, efficient pumps and motors to project	CIP Remodel or Renovation	928	Electric, Natural Gas
Overpark Tenant Spaces--10th Ave Press	FY 2001	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	73	Electric, Steam
Atrium	FY 2001	Replace chiller and mixing boxes, upgrades motors and lights, add digital controls	Whole Building Energy Improvement	4538	Electric, Steam
Task Light Turn in	FY 2002	Replace incandescents with CFLs in desk lamps	Ongoing CityWide Program	32	Electric
Building #12 remodel	FY 2002	Upgrade from T-12 to T-8 lighting in conjunction with remodel	CIP Remodel or Renovation	35	Electric
City Council Lighting	FY 2002	Upgrade lighting in conjunction with ceiling renovation	CIP Remodel or Renovation	16	Electric, Steam, Natural Gas
Westmoreland CC Gym Lighting Upgrade	FY 2002	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	49	Electric, Natural Gas
PW Transportation-office and bays	FY 2002	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	64	Electric
Campbell Center Lighting	FY 2002	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	16	Electric, Natural Gas
City Hall-Lighting Maintenance	FY 2002	HRRS, CMO and Police Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	365	Electric, Steam, Natural Gas
Overpark Tenant Spaces--Remaining spaces	FY 2002	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	221	Electric, Steam
Overpark Tenant Spaces--Sam Duck/Gilligan	FY 2002	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	60	Electric, Steam
PWM Maintenance Relamping	FY 2002	Upgrade from T-12 to T-8 lighting	Operations and Maintenance Project	228	Electric, Natural Gas
New Library	FY 2003	Advanced lighting, HVAC and control features to reduce energy use by 30%	New Construction	1500	Electric, Natural Gas
Footwarmer Program	FY 2004	Supply low wattage replacements space heaters	Ongoing CityWide Program	167	Electric
Roosevelt Police Facility	FY 2004	Upgrade lighting and HVAC beyond code requirements	CIP Remodel or Renovation	101	Electric