Roadmap for Climate Protection: Reducing Greenhouse Gas Emissions in Puget Sound

The Puget Sound Clean Air Agency
Climate Protection Advisory Committee

Prepared with the Assistance of: Ross & Associates Environmental Consulting, Tellus Institute, The Center for Clean Air Policy, and Thomas D. Peterson

12/29/04

December 29, 2004

Honorable Members
Board of Directors
Puget Sound Clean Air Agency

Ladies and Gentlemen:

We, the members of the Climate Protection Advisory Committee convened by the Puget Sound Clean Air Agency in January 2004, are pleased to present you with our final report and recommendations. We are members of organizations with various and different experiences, responsibilities, and roles regarding climate change. Our diversity has been our strength as we came together in good faith seeking to provide direction on effective ways to reduce greenhouse gas emissions in the Puget Sound region, as you charged us to do.

We have come to a consensus on the need for action and have recommended several critical priorities and key actions needed to put the region on the path to reducing greenhouse gas emissions and contributing to climate stabilization. Unless noted in the report, we support the recommendations presented here and will, each in our own way and within the relevancy, expertise, and decision-making of our own organization, continue to participate constructively in their development and implementation. We urge that the Puget Sound Clean Air Agency continue its important leadership on this issue, informed and guided by these recommendations.

We want to gratefully acknowledge and express our appreciation for the support we received in our efforts from the many volunteers who participated as Technical Working Group members and the Agency's staff. We thank you for the opportunity to participate and to contribute to this effort, and we appreciate your leadership and vision on this vitally important issue.

Sincerely,
Climate Protection Advisory Committee Members

Rod Brandon, King County EO/PSDM

Stephen Gerritson, Commuter Challenge

Karin Bulova, Snohomish County PUD*

David Goldberg, AIA, Mithun Architects + Designers + Planners

John Cabaniss, Association of International Automobile Manufacturers**

KC Golden, Climate Solutions

Kim Drury, City of Seattle

CPAC Co-chair, Wayne Grotheer, Port of Seattle

Gene Duvernoy, Cascade Land Conservancy

Frank Holmes, Western State Petroleum Association

CPAC Co-chair, Jake Fey, WSU Coop-Extension Energy Program

Ken Johnson, Weyerhaeuser Company

Diana Gale, Cascade Center for Public Service

Carol Jolly, Washington State Governor's Office

* Snohomish County PUD is reserving its signature until it has completed its own internal process to consider the recommendations.

** John Cabaniss was an active participant in the CPAC process but chose not to sign the report due to current/potential litigation regarding California Motor Vehicle Standards.

Bill Kidd, BP

Robert Pregulman, Washington PIRG

Chuck Kleeberg, Pierce County Planning and Land Services

Roby Roberts, PPM Energy, Inc.

Bill LaBorde, NW Energy Coalition

Steve Secrist, Puget Sound Energy

Kelly McGourty, Puget Sound Regional Council

Gary Smith, Small Business Owner

Dave Moore, The Boeing Company

Lucy Steers, League of Women Voters, Growth Management Chair

Stan Price, NW Energy Efficiency Council

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EXECUTIVE SUMMARY

Global warming is happening and poses an urgent challenge to the citizens in the central Puget Sound region and the world over. Human actions—primarily fossil fuel burning—are the key cause of the problem; and thoughtful, focused human action is the key to the solution. Practical greenhouse gas reduction actions taken now, if implemented quickly and wisely, can help reduce the risks from a warming climate and deliver considerable economic benefits to the Puget Sound region. Significant greenhouse gas emission reductions will be needed over time to stabilize the climate—acting now will make that journey easier and more effective. Acting now will also help ensure that our communities are better positioned to prosper in a world that is transitioning to a low-carbon economy. The Puget Sound region must embrace this challenge directly and decisively.

These are the primary conclusions of the Climate Protection Advisory Committee (CPAC), a group of stakeholders from business, government, and public interest organizations convened to advise the Puget Sound Clean Air Agency Board of Directors on a climate change action strategy. At the request of Washington State Governor Gary Locke, the CPAC also offers recommendations for statewide action to inform the State of Washington's participation in the West Coast Governors' Global Warming Initiative.

The CPAC's report lays out a set of near-term recommendations that will allow the region to turn the corner on global warming emissions—from today's trajectory of increasing emissions to a downward slope within this decade, and significant reductions from today's emissions levels by 2020. It identifies the possibility of large, sustained economic gains associated with the recommended actions. And it calls for development of a longer-term comprehensive framework to reduce greenhouse gas emissions to the levels necessary to stabilize the climate over time.

WHY ACT?

Our region's natural and human-engineered systems are elaborately adapted to long standing climate patterns and rhythms. Abundant winter precipitation, stored as snow in the mountains, anchors our economy and environment. This snowpack is the storage for our hydroelectric system, which produces the nation's cleanest and least costly power supplies. It is essential for our region's and state's agricultural productivity. It provides year-round water supply for people and habitat for salmon. Water, stored as snow, is a critical element of our natural capital. Our customary release and use of this water, based on historic climate patterns, is a critical feature of our natural infrastructure.

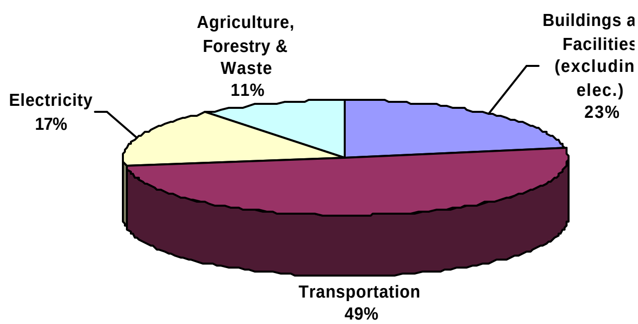
But these historic climate patterns have already begun to change due to global warming, and scientific consensus predicts that the trend toward a warmer climate will continue unless humans tackle this problem. The Washington Cascades snowpack (or snow water equivalent) has already been reduced by approximately 50% for the period 1950-1995. It is estimated that continued global warming will reduce this precious resource by another 59% by 2050—within the working lifetime of a current college freshman.

Other anticipated climate impacts on the region include: loss of forests to pests and wildfire (and the impact of particulate matter produced by wildfires on air pollution and human health); coastal erosion due to sea-level rise; and more extreme weather events and flooding. Clearly, the impacts from global warming are not just regional; all human and natural systems depend on climate stability, so unchecked global warming would cause widespread disruption of ecosystems and economies.

WHY ACT LOCALLY?

While no single jurisdiction or region can engineer a complete solution to global warming, every place has something to contribute. As such, we need to be a part of the solution. In many cases, reducing greenhouse gas emissions can help us achieve other important local priorities: reducing traffic and sprawl; stabilizing and reducing energy costs; protecting our land, air, and water resources; and increasing the competitiveness of our businesses and industries.

Share of GHG Emissions by Sector, 2000



Most of the world's advanced industrial economies have already formally launched their transition to a low-greenhouse gas future through adoption of the Kyoto treaty. While the U.S. has not ratified the Kyoto treaty, many businesses, states, and local governments here at home are developing and implementing plans to reduce greenhouse gas emissions. They are doing so in response to both the risks and the opportunities that the climate challenge presents. They are positioning their economies for survival and success as the world makes the transition to cleaner, more efficient energy sources and uses.

This region, more than most, can be a leader in solutions. Our extraordinary abundance of technical talent, entrepreneurial skill, and human and natural capital position us to be pioneers in the businesses and policies that will protect the climate. The CPAC believes that the Puget Sound can do more than reduce its own emissions. We are among the best-qualified communities anywhere to pioneer solutions with both local benefits and global applications.

GOALS

The CPAC believes that global warming is occurring, is largely triggered by human actions, and that human induced greenhouse gas emissions must be sufficiently reduced to achieve climate stabilization. The specific emission reduction goals necessary to do so will be set by the science. The CPAC's recommendations, however, represent promising first steps on the path to climate stability. On the way to this long-term goal, the CPAC recommends the following principles guide the region's efforts.

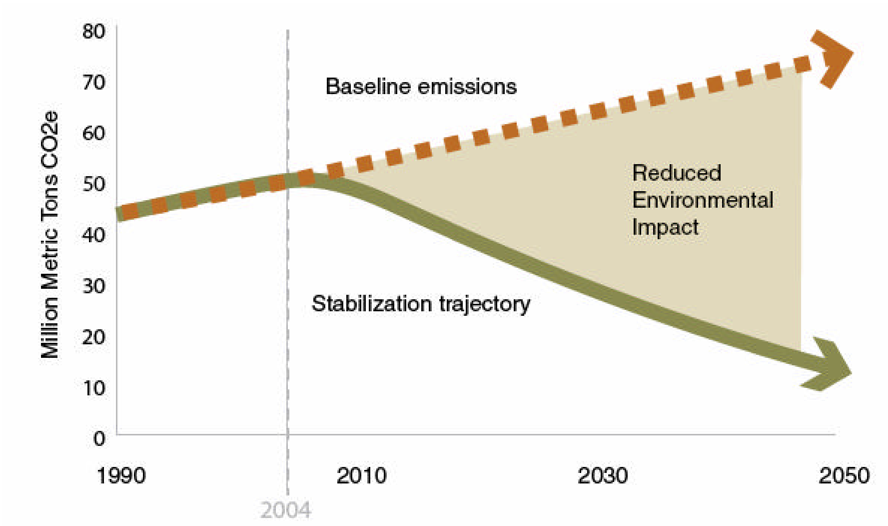
Begin now, and begin with determination. The CPAC's key action recommendations can produce significant financial benefits in the form of lower energy costs. With fossil fuel prices near record highs, these actions deliver large long term economic benefits. With so much at stake and such an attractive first step at hand, now is the time to take these recommendations, craft their implementation path, and put them to work for the region.

Crest the hill as quickly as possible. Achieve declining emissions by 2010. While climate science calls for deep reductions in global warming pollution, emissions in our region are still on the rise. Unchecked, the region is projected to emit 40% more greenhouse gases in 2020 than we did in 1990. Very early, in what will clearly be a long journey toward climate stabilization, we need to turn this emission curve downward. These recommendations, properly designed and implemented, can help do so.

Chart a course to the ultimate goal. Having crested the hill, the region needs to chart a course for reducing greenhouse gas emissions to the levels needed for climate stabilization. From a scientific perspective, the steeper that curve in the near-term, the better. The sooner we achieve reductions, the smaller the impacts will be. We ask that the Clean Air Agency consider the science, set interim and long-term reduction goals, and identify timeframes for action to organize and galvanize the region for the long haul toward climate stabilization. We believe that the ultimate success of the region's climate strategy depends on a clear, measurable, results-oriented framework for action, including goals, timetables, and predictable limits on greenhouse gas emissions.

The CPAC did not identify specific emission reduction goals on the line toward climate stabilization. We have recommended a *trajectory* and a set of recommended actions that constitute necessary, promising first steps in moving our region along that course. As we deliver these directional recommendations to the Puget Sound Clean Air Agency Board and other decision-makers, including the West Coast Governors and the Washington State Legislature and Governor, we urge them to implement those that are ready to go, flesh out those that need further work, and continue to look for additional actions and opportunities that go beyond the CPAC's recommendations.

Puget Sound GHG Emissions 1990–2050



PRIORITY RECOMMENDATIONS AND KEY ACTION ITEMS

Because global warming is truly a global issue, the CPAC recommends one overarching action to the Puget Sound Clean Air Agency: The Puget Sound Clean Air Agency must actively and aggressively participate in efforts to achieve greenhouse gas emission reductions in Washington State, the west coast, nationally and internationally to the maximum extent possible.

In addition to this call for action, the CPAC has identified eight priority recommendations and associated key action items for the region to pursue. The technical analyses indicate that implementing the CPAC's recommendations would result in a reduction of Puget Sound regional GHG emissions back to its 1990 levels and boost the region's economy between $1.4 billion-$2 billion over the next 15 years.

Emission Savings from Key Actions (Million Metric Tons CO2e)

	2010	2020
Buildings, Facilities, Electricity Supply	2.9	7.9
Transportation	0.8	4.9
Agriculture, Forestry & Waste	2.3	3.9
Total	6.0	16.6

1. **Maximize energy efficiency and increase renewable energy in the region's power mix.** Energy-efficient lights, appliances, and buildings can save electricity more cheaply than new

power plants can produce it. Successful utility efficiency programs and building and construction codes have shown that this “saved” energy can be used to meet new demand, providing both a cost-effective energy resource and major reductions in GHG emissions. As well, recent successes in developing renewables such as wind power, demonstrate that the region is poised to accelerate development of renewable energy supplies, build its clean energy industry, and begin to replace carbon-based fuels in the region's existing supply as appropriate. Key actions:

- Develop standards (or other appropriate mechanisms) that promote meeting new load growth with cost-effective energy efficiencies and renewable energy supplies.
- Develop standards that support the use of renewable resources when retiring/replacing existing fuel sources.
- Enact state energy efficiency standards for selected appliances and products.
- Upgrade the non-residential state energy code and improve local level enforcement, training, and education.

2. **Reduce the greenhouse gas emissions of new vehicles sold:** Petroleum used in transportation accounts for over half the region’s GHG emissions. Achieving major reductions from this sector requires steady and significant declines in the emissions these vehicles produce. Key actions:
   - Actively participate and engage in efforts to urge the federal government to achieve improvements in fuel economy
   - Adopt California Motor Vehicle standards, which will require stricter emissions standards for new cars sold in Washington State.[1]

3. **Reduce motor vehicle miles traveled:** Reducing overall vehicle miles traveled and providing better alternatives to single-occupancy vehicles are both existing regional priorities and a crucial part of any effective strategy for reducing global warming emissions. Key actions:

   - Establish a vehicle miles traveled reduction goal.
   - Implement a series of transit, land-use, and demand reduction strategies.
   - Incorporate climate protection policies and goals into regional transportation and land-use planning, such as described in the Puget Sound Regional Council’s Destination 2030 plan.

4. **Protect natural landscapes and forest biomass:** The Puget Sound Region is blessed with a large and basically still intact base of lowland forested lands, working farms, parks and other natural areas. This significant resource can and should be a significant part of the

[1] Adopting California Motor Vehicle Standards is not a consensus recommendation. The Association of International Automobile Manufacturers did not support adopting these standards. Details regarding the differing perspectives are included in Chapter Six of the report.

climate solution. Managed appropriately, they can store or "sequester" carbon, providing a way to reduce the concentration of carbon in the atmosphere while emission reduction strategies take hold. Key action:

- ➔ Protect and enhance the GHG reduction potential of Puget Sound forests and other working landscapes. Specific actions include forest land conservation; providing incentives to property owners; and forest retention associated with land development

5. **Increase recycling and composting rates; reduce waste**: Reducing, reusing, and recycling waste can significantly reduce GHG emissions in all phases of a product's lifecycle, while also protecting the environment, conserving resources and lowering waste management costs and impacts. Key actions:

   - ➔ Increase food waste composting and waste wood and mixed paper recovery rates to 45%, 50%, and 58% respectively by 2010; increase paper, plastic, metals and other materials recovery rates by 5-20%.

6. **Develop and adopt a climate change policy framework:** An effective climate strategy must combine countless individual actions that collectively reduce GHG concentrations in the atmosphere sufficient to stabilize the climate. These many individual measures must be bound together with a results-oriented policy framework that lends structure, coherence, pace, and accountability to the enterprise. Key actions:

   - ➔ Adopt explicit goals and timelines for GHG reduction.
   - ➔ Establish fair, predictable targets on GHG emissions across sectors and use flexible market-based trading systems, such as a national or regional Cap and Trade, which,,when properly constructed and with appropriate regulatory support, will allow the goals to be reached as efficiently as possible.

7. **Promote public education and citizen/corporate/government action:** Solutions to global warming require action at all levels, from high-level policy development to business investment to individual behavior change. Active engagement by all sectors and a clear understanding of the challenges and opportunities posed by global warming by all citizens are essential. Key action:

   - ➔ Develop a communication and awareness strategy that includes: broad-based climate education; actionable messages; outreach partnerships with related efforts and institutions; and targeted education/advocacy for specific audiences that can implement high-priority GHG reduction strategies.

8. **Encourage Local Government to Act:** Local governments can and should take significant steps to contribute to reducing GHG emissions. They can influence GHG emissions in

several key ways (entities in the private sector can also influence GHG emissions in many of the same ways), including:

- Leading by example
- Creating partnerships and leverage existing opportunities
- Advocating for GHG emission reduction actions
- Providing technical assistance, funding, incentives and regulation

CONCLUSION

The CPAC's conclusions and recommendations are a good beginning. We hope they help the Clean Air Agency develop a sustained, focused, and effective regional climate change action plan. Much remains to be done to deliver on the promise of the actions in this report. In particular, we urge the Clean Air Agency, as it reviews our recommendations and determines its next course of action, to consider the following roles or actions to provide critical leadership:

1. Advocate and engage with the state and the federal government for action on those recommendations that promote solutions at a scale larger than the central Puget Sound.
2. Support the local governments in the Clean Air Agency jurisdiction as they develop the knowledge and tools needed to reduce GHG emissions.
3. Build partnerships with local governments, business, communities and others to better understand the opportunities and barriers that we face as we move forward.
4. Establish the policy framework needed to set goals, establish timelines and assess progress on the road to climate stabilization.
5. Educate all citizens of the region regarding the causes of global warming and the potential feasible actions and decisions people and businesses can take to make a contribution to the solution.

The recommended actions are just a first step on the ultimate road to climate stabilization. This region, and all regions, will need to stay the course to be successful, ensuring the commitment of all parties and sectors and investing appropriate public and private sector resources. While the challenge may seem formidable, the first steps are well-understood and appear economically attractive. For the future of both our environment and our economy, we can and must begin immediately.

The CPAC members represent the diversity of interests needed to work together over time to successfully achieve climate stabilization. We have converged on the direction we must follow and identified the first essential steps we should take. Our success in doing so reflects the compelling nature of the global warming challenge and hopefully contributes to the momentum and confidence needed to meet this challenge. We urge the Clean Air Agency, and all readers of this report, to determine what they can do to move our recommendations forward and explore how to surpass them, as well.

1. INTRODUCTION

This report is the product of the Puget Sound Clean Air Agency's (CAA) Climate Protection Advisory Committee (CPAC)[2], a diverse group of governmental, business, and community/environmental representatives from around the Puget Sound.[3] It reflects the group's strong consensus that action to protect the climate is necessary and economically attractive. The report identifies strategies and actions that Puget Sound and Washington State governments, communities, businesses, and private citizens can take to reduce greenhouse gas (GHG) emissions. **The CPAC believes that the Puget Sound region and the State of Washington can and must join the effort to reduce greenhouse gases and help reverse the trend towards a warmer climate**.

PUGET SOUND CLEAN AIR AGENCY CLIMATE PROTECTION CHARGE AND PROCESS

The CPAC was convened by the CAA Board of Directors in January 2004 to provide direction to the CAA and the Puget Sound region on climate protection strategies.[4] The CAA Board of Directors charged the CPAC to "recommend to the Clean Air Agency a GHG emission reduction goal and range of strategies to reduce GHG emissions"[5] and to focus on Snohomish, King, Kitsap, and Pierce Counties, the Agency's jurisdiction. The CPAC was asked to concentrate its efforts, specifically, on actions the CAA and the local governments it works closely with can take to advance climate change goals. At the same time, the CPAC was asked to consider actions that might be necessary at a state-wide, multi-state and/or national level to assist the region in its effort to combat climate change. Washington State Governor Locke explicitly supported the CPAC process and noted that he would consult the CPAC's recommendations to develop statewide programs as part of a regional global warming initiative undertaken in partnership with the governors of Oregon and California.[6] Finally, the CPAC was asked to develop strategies that are "directional" in nature, meaning that they offer a general approach or framework but do not necessarily lay out the specific implementation pathway, including schedule, key entities, regulatory framework, or budget estimate.[7]

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[2] A full list of CPAC members is included in Appendix A.

[3] A representative of the Association of International Automobile Manufacturers, based in the Washington, D.C. metropolitan area also participated in the process.

[4] http://www.pscleanair.org/specprog/globclim/cpsp/index.shtml

[5] The Climate Protection Process Draft Advisory Charter can be found at http://www.pscleanair.org/specprog/globclim/cpsp/pdf/cpac_char.pdf

[6] See http://www.pscleanair.org/specprog/globclim/cpsp/pdf/lockeltr.pdf for text of Governor Locke's letter to the CPAC.

[7] Such work will obviously be needed to implement these directional strategies. The CPAC assumes that the implementing parties will determine the most appropriate approach and timeline for any given action.

The CPAC met six times and over the course of its deliberations discussed the GHG-reduction potential, costs, benefits, and challenges of specific actions and strategies. The CPAC's discussions were supported and supplemented by four technical working groups (TWGs)[8] representing each of the major sectors that emit global warming pollution: Electricity Supply (ES); Buildings and Facilities (BF); Transportation (T); and Agriculture, Forestry and Solid Waste (AFSW).[9] CPAC members were also active participants of the TWG's which met several times during the course of this project.

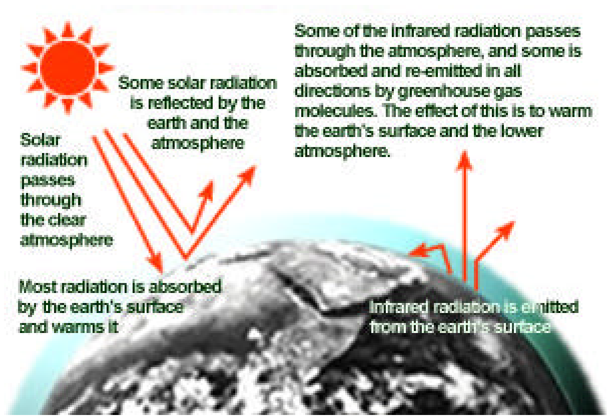
[8] Rosters for each of the TWGs are included in Appendix B

[9] See Appendix C for further information regarding process structure.

2. WHAT IS CLIMATE CHANGE AND HOW WILL IT IMPACT THE PACIFIC NORTHWEST

WHAT IS CLIMATE CHANGE?

Figure A: The Greenhouse Effect



Source: US EPA

The 'greenhouse effect', as it is commonly called, is a naturally occurring process in the Earth's atmosphere that helps retain solar heat, keeping the Earth's temperature warm enough to support life. Energy from the sun, in the form of light, is absorbed by the Earth's surface. Some of this energy is then radiated back into the atmosphere, heating up the air. Some of the gases (called greenhouse gases or GHGs')[10] in the Earth's atmosphere interact with that energy and 'trap' the radiated heat, helping to further raise the temperature of the atmosphere and the Earth's surface.[11] Increases in these GHGs increase the amount of heat trapped by the atmosphere and cause overall warming of the planet. This warming is referred to as global warming and the various impacts from global warming are referred to as climate change. (See Figure A.)

EVIDENCE OF CLIMATE CHANGE

The United Nations Intergovernmental Panel on Climate Change (IPCC), the world's leading collection of scientists, concluded in its most recent assessment that "an increasing body of observations gives a collective picture of a warming world and other changes in the climate system."[12] The IPCC report was based on its assessment of thousands of peer-reviewed and published scientific/technical articles.

[10] GHGs include water vapor, carbon dioxide, methane nitrous oxide, aerosols, hydrofluorocarbons and perfluorocarbons and other gases.

[11] This phenomenon is similar to what happens in a greenhouse, with the glass roof of a greenhouse acting like the gases do in the atmosphere; thus the use of the term 'greenhouse.'

[12] Intergovernmental Panel on Climate Change (IPCC) Working Group One, Climate Change 2001: The Scientific Bases. Summary for Policy-makers.< http://www.grida.no/climate/ipcc_tar/wg1/008.htm>

In its analysis, the IPCC found that:[13]

- The global average surface temperature has increased over the 20th century by approximately 1.1 degree Fahrenheit.
- Temperatures have risen during the past four decades in the lowest eight kilometers of the atmosphere.
- Snow cover and ice extent across the planet have decreased, including through melting of permafrost and glaciers. Similarly, there has been an approximately 40% decline in Arctic sea-ice thickness during late summer to early autumn.
- The global average sea level has risen four to eight inches during the 20th century. At the same time, ocean heat content has increased.

The IPCC report notes that the globally averaged surface temperature is projected to increase by 2.5-10.4 degrees Fahrenheit over the period of 1990 to 2100.[14] Regional or localized warming may be greater or less than the global average due to other factors such as regional or global weather patterns.[15] Given the impacts observed from the 1.1 degrees Fahrenheit temperature increase that has already occurred, a surface temperature increase at even the lower end of the IPCC's projection implies significant changes in climate.

WHAT CAUSES CLIMATE CHANGE?

Climate varies based on natural as well as human activities; however, natural variations in the climate can be distinguished from human-induced climate change. Natural causes of climate change include airborne releases from volcanic activity and changes in solar radiation. The primary way humans contribute to increased GHGs is by burning fossil fuels (coal, natural gas, petroleum).[16]

Analysis of the current pattern of climate change indicates that the recent warming trend is largely the result of human-caused increases in GHGs and that these GHGs are now the dominant driver of the observable changes in the Earth's climate.[17] The IPCC has concluded that concentrations of atmospheric GHGs have continued to increase at a significant rate of change as a result of human activities.[18] For example, the atmospheric concentration of carbon dioxide (CO_2) has

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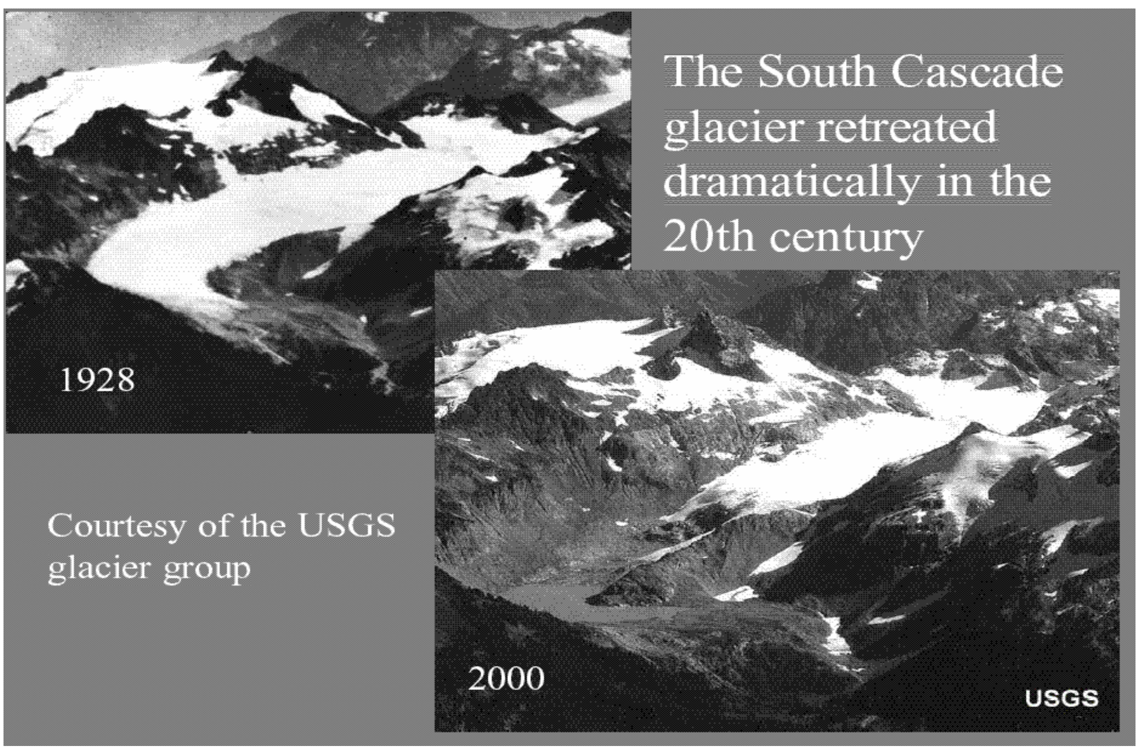
[13] Ibid.
[14] Ibid.
[15] Pew Charitable Trust, , Frequently Asked Questions, < http://www.pewclimate.org/global-warming-basics/faq_s/glance_faq_science.cfm> (cited 25 October 2004)
[16] Other factors include land use practices, primarily deforestation.
[17] Philip Mote, Will the Northwest Notice a Changing Climate? University of Washington, (January 21, 2004 presentation to the CPAC.).
[18] IPCC Third Assessment Report – The Scientific Basis.

increased 31% since 1750.[19] Production of methane (CH_4), another GHG, has increased 150% since 1750.[20] The rates at which GHGs are released from combustion of fossil fuels and depressing photosynthesis from plants through land clearing continue to accelerate.

LOCAL IMPACTS OF CLIMATE CHANGE

Data collection stations across the Pacific Northwest region have recorded a 1.5 degrees average temperature increase over the last 80 years in both urban and rural areas. In fact, the 1990s was the warmest decade on record. Across much of the region, spring snowmelt now occurs 10-30 days earlier than it did 50 years ago and April 1 snowpack levels below 6,000 feet have shown approximately 30 percent declines.[21] Research also indicates that the region's glaciers have lost some 30 percent of their girth in the last century. For example, the South Cascade Glacier outside of the North Cascades National Park has lost a third of its mass in 45 years. The Nisqually glacier on Mt. Rainer has drawn back nine-tenths of a mile since the early 1900's.

Figure B:



Source: US Geological Survey

[19] Ice core samples covering hundreds of thousands of years indicate that CO_2 levels were very stable in a range for centuries, until the Industrial Revolution at which time human activity began putting CO_2 into the air faster than nature, primarily through photosynthesis in plants , can take it out.
[20] Philip Mote. Will the Northwest Notice a Changing Climate?
[21] Climate Impacts Group, Overview of Climate Change Impacts in the U.S. Pacific Northwest, University of Washington, July 29, 2004.

Climate change experts from across the Pacific Northwest met in Oregon on June 15, 2004. Following the meeting, 49 of the scientists who attended signed a consensus statement declaring, in part, that regional climate change is underway and is likely to have noticeable global effects as well as environmental impacts in the Pacific Northwest.[22] The group discussed several likely future climate changes and impacts, including the following: increases in average temperatures (and associated increased length of fire season); changes in precipitation regimes (including increases in winter precipitation and decreases in summer precipitation); changes in streamflow; and reductions in overall snowpack.

Projected Pacific Northwest Impacts

Annual Average Temperatures

Scientists predict that average temperatures in the Pacific Northwest will continue to increase in response to global climate change. Modeling exercises project a further warming of 0.5–2.5 °C (central estimate 1.5 °C) by the 2020s and 1.5–3.2 °C (2.3 °C) by the 2040s.[23] The long-term weather trends for the Northwest resulting from climate change are predicted to bring wetter winters and warmer, drier summers. The potential implications of these Pacific Northwest warming patterns are significant and troubling. Several of these impacts are discussed below.

Water Resources

Cascade mountain snowpack essentially acts as an additional reservoir, holding water until summer months when snow melt adds to municipal and agricultural water supplies to meet increased seasonal demands and augment stream flow levels for fish and wildlife. Scientists predict that the most critical impact of a warming Pacific Northwest climate will be the reduction of regional snowpack, which presently supplies water for ecosystems and human uses during the dry summers. In particular, warmer winters are predicted to result in reduced snowpack at low-to-mid elevations. Warmer winters will also lead to an increase in winter rainfall (vs. snow) which, in turn, will increase winter streamflows and the tendency for rain-induced winter flooding. Rain will also cause snow that does accumulate to melt quickly, adding to winter flow volumes. As a result, the region can expect to experience earlier spring runoff and reduced summer flows, when the demand for water is greatest. The snowpack in the Cascade Mountains of Washington and Oregon is projected to decrease 59% by 2050 and 72% by the 2090s.[24] Some areas near

[22] "Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest—Executive Summary", Proceedings of the Impacts of Climate Change on the Pacific Northwest Symposium, June 15, 2004, signed by 49 Ph.D-level scientists with expertise on the impacts of climate change in the Pacific Northwest, http://inr.oregonstate.edu/policy/climate_impacts_consensus_statement.pdf

[23] Philip W. Mote, Edward A. Parson, Alan F. Hamlet, William S. Keeton, Dennis Lettenmaier, Nathan Mantua, Edward L. Miles, David W. Peterson, David L. Peterson, Richard Slaughter, Amy K. Snover, Preparing for Climatic Change: The Water, Salmon, and Forests of the Pacific Northwest, Climatic Change, Volume 61, Issue 1-2, November 2003: 45 - 88

[24] Philip Mote. Will the Northwest Notice a Changing Climate?

snowline could see snowpack drop by up to 90 percent.[25] The decreased snowpack and changing flow regimes can adversely impact hydroelectric operations, summer water supply, irrigation reliability, and salmon habitat.

Shorelines

The IPCC's Third Assessment Report notes that global mean sea level is projected to rise by 3.6-34.7 inches (0.09 to 0.88 meters) between 1990 and 2100, compared to the global average sea level rise during the 20th century of 3.9-7.9 inches (0.1-0.2 meters).[26] Sea level rise resulting from the melting of the polar icecaps and thermal expansion of the oceans, when coupled with increased winter precipitation, is predicted to cause coastal erosion, shorelines retreat, and landslides in the Pacific Northwest.[27] This sea level rise could inundate low-lying areas and reduce the extent of coastal wetlands.

Salmon

Climate change is likely to create severe pressure for already stressed Puget Sound salmon populations by impacting their physical environment, including the availability of food. Decreased and warmer summer flows in streams and lakes, increased salinity and pollutant concentrations, and changes in the ecosystem and food availability are likely impacts of climate change that would stress sensitive salmonid species.[28] As well, winter flooding and resulting stream scouring is expected to further degrade instream and estuarine salmon habitat throughout the region.[29]

Forests

The potential impacts of climate change on the region's forests vary: some scenarios project increases in forest growth while others predict forest dieback. Notwithstanding these differences, it is likely that drier, warmer, summer weather accompanied by reduced late spring-to-summer runoff will increase drought and the risk of forest fire. Increased forest fires will also produce increased particulate matter, impacting air pollution and human health. A hotter climate could also lead to more noxious pest infections as trees are often more susceptible to pests and disease when stressed by heat and lack of water. In British Columbia, for examples, warmer winters have been cited as a major cause of the Mountain Pine Beetle outbreak which has

[25] Patrick Mazza, "In Hot Water: A Snapshot of the Northwest's Changing Climate," http://www.climatesolutions.org/pubs/inHotWater.htm. (cited 25 October 2004)

[26] IPCC Third Assessment Report – The Scientific Basis. http://grida.no/climate/ipcc_tar/wg1/005.htm and <http://grida.no/climate/ipcc_tar/wg1/008.htm>

[27] Climate Impacts Group, Overview of Climate Change Impacts in the U.S. Pacific Northwest, University of Washington, July 29, 2004.

[28] "Scientific Consensus Statement on the Likely Impacts of Climate Change on the Pacific Northwest—Executive Summary", Proceedings of the Impacts of Climate Change on the Pacific Northwest Symposium, June 15, 2004, signed by 49 Ph.D-level scientists, http://inr.oregonstate.edu/policy/climate_impacts_consensus_statement.pdf

[29] Climate Impacts Group, Overview of Climate Change Impacts in the U.S. Pacific Northwest, University of Washington, July 29, 2004.

already destroyed an area of forest more than five times as large as Vancouver Island and contributed to unusually severe forest fires.[30]

At lower elevations, forests compete for water with other vegetation. Drought conditions increase this competition and could limit growth of some trees. A key uncertainty is whether increased CO_2 levels will increase forest growth or if hotter temperatures will counter that effect. Regardless, it seems likely that climate change will cause plant communities to experience shifts in species composition and/or densities.[31]

What Other Jurisdictions Are Doing

Central Puget Sound jurisdictions are not alone in the quest to curb GHGs and curtail the effects of global climate change. In fact, local, state-level, regional consortia, federal, and international efforts at multiple scales abound in the search for climate change solutions. Like the Pacific Northwest communities participating in the Climate Protection Advisory Committee Process, these other governmental (and non-governmental) entities recognize the environmental, economic and social imperative such efforts represent. A brief overview of climate change protection activities around the world and across the U.S. demonstrates the range of potential climate change solutions.

International

Significant global climate change activities are underway around the globe, many of which come together under the auspices of the United Nations Framework Convention on Climate Change. As of June 2003, 110 countries, as well as the European Community, had ratified the 1997 Kyoto Protocol, a system of national limits on global warming pollution, timetables for reductions, and a market-based credit trading system. Russia ratified the Kyoto Protocol most recently on October 22, 2004. The Protocol will enter into force on February 16, 2005. Significantly, the U.S. has not ratified the Kyoto Protocol.

The European Union (EU) has taken significant action to curb its GHG emissions. To support and advance its efforts, the European Commission established the European Climate Change Programme (ECCP) in 2000 to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. The ECCP led to the adoption and implementation of a range of new policies and measures, including the EU's GHG emission trading scheme (ETS), which will be launched on January 1, 2005.[32] The ETS will be the largest multi-country, multi-sector GHG emission trading scheme on the planet. The latest monitoring data indicates that the EU has

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[30] David Suzuki Foundation. Climate Change Impacts in British Columbia. http://www.davidsuzuki.org/Climate_Change/BC/Impacts.asp

[31] Intergovernmental Panel on Climate Change, J. T. Houghton, L. G. Meira Fihlo, B. A. Callander, N. Harris, A. Kattenberg and K. Maskell (eds.). 1996a. Climate Change 1995: The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press).

[32] For additional details on the EU emissions trading scheme, see http://europa.eu.int/comm/environment/climat/emission.htm.

reached its long-standing commitment to stabilize CO_2 emissions at 1990 levels in the year 2000. The EU-15 remains committed to collectively reduce emissions by eight percent by 2008-2012, in keeping with the Kyoto Protocol. Ongoing activities include research into the potential for carbon sequestration in EU forests and the promotion of biofuels.

The United Nations Environment Program established the “Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific” (GERIAP) project in 2002 to support and encourage Asian businesses in addressing climate change by becoming more energy efficient, thus reducing their GHG emissions and costs. The Asia Pacific region is a critically important component to reducing GHGs worldwide as the region is home to 3.2 billion people, represents 40% of the global economy, and is predicted to support the highest rate in GHG emissions growth in the future, especially as a result of industrial growth. GERIAP, which runs until December 2005, focuses its efforts on identifying actions that concurrently reduce industry GHG emissions and operating costs. Participating countries include Bangladesh, China, India, Indonesia, Mongolia, Philippines, Sri Lanka, Thailand, and Vietnam.

Brazil has taken independent steps to reduce its GHG emissions. The Pew Center on Global Climate Change reports that Brazil was able to curtail its GHG emission increases by 10% in 2000 through an aggressive program to produce and promote the use of ethanol and sugarcane-based and other biofuels, increase energy efficiency in the electricity sector (e.g., through the import of natural gas and the development of gas co-generation facilities), and through reforestation efforts designed to increase carbon sequestration and offset carbon losses caused by deforestation and other land use changes. Brazil has also introduced tax incentives to encourage citizens to purchase low-power vehicles.[33] Mexico has taken similar steps, focusing its GHG emission reduction activities on increasing the use of natural gas (instead of other more carbon-intensive fuels), reducing deforestation, and promoting energy efficiency. Collectively, the country’s actions have reduced GHG emissions by more than 50 million tons in the past decade.[34]

State, Regional, and National Efforts

Twenty-eight U.S. states and Puerto Rico have developed, or are developing, specific strategies or plans to reduce GHG emissions. Several establish numeric GHG emission reduction targets (often out to 2020 or 2050) and describe specific actions to meet those targets. Many states also support significant research efforts (e.g., looking at ways to increase carbon sequestration in soils (Nebraska, Wyoming, North Dakota, Oklahoma, Illinois) or designing cost-effective conservation services for low-income households (Colorado)).

Several New England states have prepared detailed GHG-reduction strategies in recent years. In 2001, the New England Governors/Eastern Canadian Premiers group (composed of six U.S. Governors and five Canadian Premiers) approved a comprehensive Climate Change Action Plan

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[33] William Chandler, Roberto Schaeffer, Zhou Dadi, P.R. Shukla, Fernando Tudela, Ogunlade Davidson, Sema Alpan-Atamer. 2002. Climate Change Mitigation in Developing Countries: Brazil, China, India, Mexico, South Africa, and Turkey, Prepared for the Pew Center on Global Climate Change.
[34] Ibid.

to jointly reduce GHG emissions. The Plan sets specific emission reduction targets and calls for the establishment of a standardized emissions registry and inventory, an important step to establishing an emissions trading mechanism. The Governor of New York followed up on this action in April 2003 by inviting ten neighboring states to participate in a regional cap and trade program for power plants. Eight states accepted the invitation and are currently engaged in designing an appropriate program.

In the Western U.S., the West Coast Governors' Global Warming Initiative, which Washington participates in alongside Oregon and California, is another such regional initiative. Launched in September 2003, the West Coast Governors' Initiative initially focused on five specific climate change issues: Hybrid Vehicle Procurement; Ports and Highway Diesel Emissions; Renewable Energy; Energy Efficiency; and Measurement. Staff Working Groups tackled each of these topics and submitted a report to the Governors' outlining their recommendations on appropriate action strategies. The report also addressed longer-range direction for the region and the value of continuing the joint effort. On November 18, 2004, the three Governors approved 36 of the report's recommendations.[35]

In recent years, the U.S. Congress has considered various pieces of legislation focused on reducing GHG emissions. Most recently, the Climate Stewardship Act of 2003 (introduced in the Senate in 2003 and in the House of Representatives in 2004) called for a reduction in GHGs to 2000 levels by 2010 and the establishment of a market-based system of tradable allowances to achieve reductions across six specific GHGs, including CO_2, CH_4, and N_2O. This Act has not yet been passed by Congress.

Local Efforts

The International Council for Local Environmental Initiatives (ICLEI) established the Cities for Climate Protection (CCP) campaign in 1993. Currently, more than 500 local governments worldwide participate in the CCP campaign, including over 140 cities and counties in the United States. Four communities within the Clean Air Agency's jurisdiction—Burien, Seattle, and Tacoma, and King County—have each passed resolutions embracing the ICLEI's pledge, and in many instances are taking action, to reduce GHG emissions from their local government operations and the communities they represent. Participating in the CCP network enables jurisdictions to access a range of planning tools, techniques, methods, technical assistance, and workshops that focus on methods to reduce GHG emissions.

The CPAC believes that the Puget Sound region and the State of Washington can and must join the effort to reduce GHGs and help reverse the trend towards a warmer climate.

[35] See http://www.governor.wa.gov/press/press-view.asp?pressRelease=1732&newsType=1

3. PUGET SOUND EMISSIONS INVENTORY AND BASELINE PROJECTIONS

To set the stage for ongoing CPAC deliberations and to help the CPAC establish GHG emission reduction goals and targets, the CPAC's technical team, in collaboration with CAA staff, prepared an inventory of historical GHG emissions using common practice guidelines from USEPA and the GHG Protocol, and a variety of local and regional data sources.[36] A business-as-usual or "baseline" projections to the year 2020 were also prepared. To do so, the technical team relied on existing economic, demographic, energy use, fuel price, and other (e.g., vehicle miles traveled or VMT) projections prepared by recognized regional entities and experts, including the Puget Sound Regional Council (PSRC), Northwest Power Planning Council (NPPC) and the region's electric utilities. The inventory and projections covered the principal GHGs—CO_2, CH_4, nitrous oxide (N_20)—and three groups of high-warming potential gases—hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

The inventory and projections were compiled separately for the four TWG focus areas[37] and considered the following emissions sources:

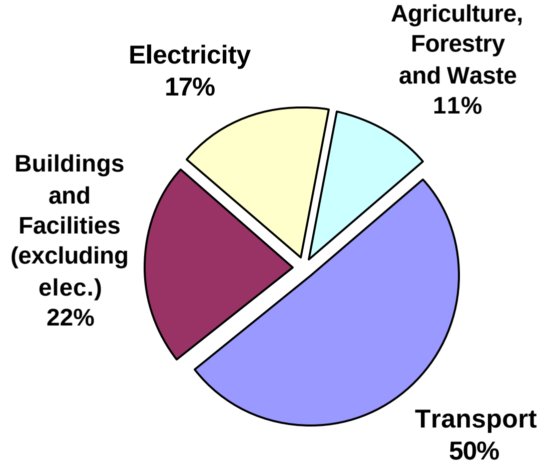
- Energy Supply (ES)—the combustion of fossil fuels to generate electricity to meet Puget Sound needs; fugitive emissions of CH_4 from natural gas systems;
- Buildings and Facilities (BF)—combustion of fossil fuels in buildings and industries; industrial process emissions (e.g. cement and lime manufacture); release of HFCs and PFCs;
- Transportation (T)—combustion of fossil fuels in vehicles and other transport-related equipment, including off-road sources; and
- Agriculture, Forestry, and Solid Waste (AFSW)—emissions and sequestration from farm and forest activities, the use of forest products, the management of solid waste and landfills, and land use change.

[36] See Appendix F for Emissions Inventory information.

[37] The inventory and baseline were prepared using data and projections from local, state and national sources, including the CAA, the Puget Sound Regional Council, the Northwest Power Planning Council, the US Forest Service and others. Key driving variables include assumptions about population growth, vehicle miles traveled, electricity sources, land use change and other factors that influence GHG emissions. The Technical Working Groups reviewed these estimates to reasonableness and consistency.

In the year 2000, the Puget Sound region[38] produced about 47 million metric tons of CO_2-equivalent[39] ($MMtCO_2e$) emissions, about half of the overall Washington state total, and slightly less than 1% of total US emissions. As shown in Figure C, half of these emissions come from the transportation sector. Buildings and facilities account for nearly a quarter, while the generation of the electricity used in these buildings and facilities adds another 17%. The remaining 11% result from agriculture, forestry, and solid waste activities.

Figure C: Puget Sound-Area Source Sector Greenhouse Gas Emissions (2000)



GHG baseline emission projections were also calculated, designed to indicate likely growth in GHG emissions by the year 2020, assuming no additional actions are taken to curb emissions. Figure D depicts the projections, broken out by target sector. Table 1 below shows the emissions for 2000 and 2020, and illustrates that while transportation accounts for the largest share of emissions, emissions are expected to grow fastest in the buildings and facilities sector and in electricity supply. These trends are in part due to the region's increasing reliance of natural gas and coal-based electricity sources to meet load growth, given that the region's hydroelectric resource is nearly fully exploited.

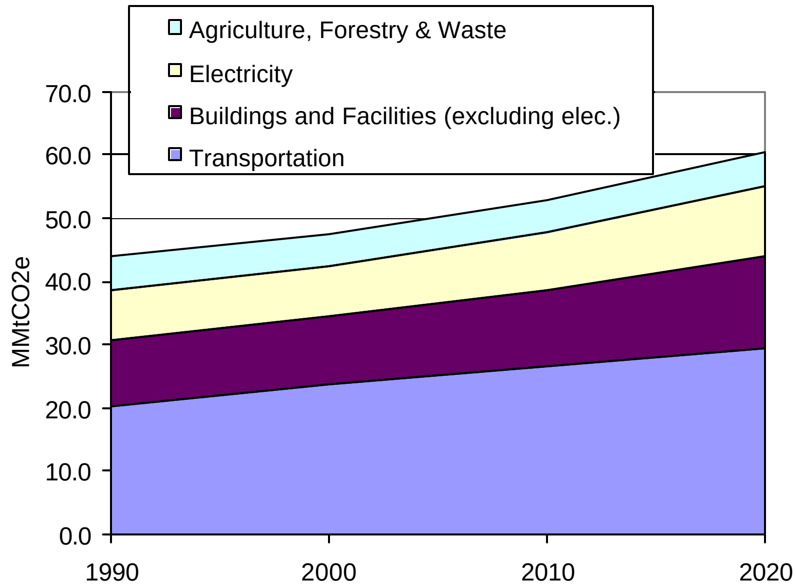
Table 1: Puget Sound Emissions by Working Group area, 2000-2020

Sector	**2000 Emissions** *($MMtCO_2e$)*	**2020 Emissions** *($MMtCO_2e$)*	**% Increase** *(from 2000 levels to 2020)*
Transportation	23.7	29.4	+24%
Energy Supply *(largely electricity use)*	7.9	11.1	+40%
Buildings/Facilities *(excluding electricity use)*	10.7	14.6	+36%
Agriculture, Forestry, Solid Waste	5.1	5.4	+5%
Total GHG emissions	47.5	60.5	+27%

[38] For purposes of the CPAC effort, the Puget Sound region refers to Snohomish, King, Pierce and Kitsap Counties.

[39] Emissions of various greenhouse gases can be aggregated to a single metric, CO2 equivalence, based on their relative radiative forcing effects over a given time span. This analysis includes the six types of gases included in the Kyoto Protocol, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, aggregated according to their 100 year IPCC Global Warming Potential

Figure D: Puget Sound GHG Emission Baseline Projections (1990-2020)



4. OVERVIEW OF CPAC RECOMMENDATIONS

PRIORITY RECOMMENDATIONS

In considering the directional path towards GHG reductions, the CPAC identified eight priority recommendations and key action items to support those recommendations. Each priority recommendation targets a key area of opportunity for GHG emission reductions. The CPAC took into consideration what the group believes is practical to implement in the coming years and is critical to reduce GHG emissions in the Puget Sound region. The CPAC does acknowledge, however, that significant reductions beyond those achieved by its recommendations are needed if the climate is to be stabilized.

The CPAC agrees that greenhouse gas reduction is one of the highest priority air quality issues and urges the Clean Air Agency Board of Directors to join in recognizing climate protection as one of its highest priority issues. Because climate change is truly a global issue, the CPAC offers the following overarching recommendation that is critical to achieving greenhouse gas emission reductions:

The Puget Sound Clean Air Agency must actively and aggressively participate in efforts to achieve greenhouse gas emission reductions in Washington State, the west coast, nationally and internationally to the maximum extent possible. The Clean Air Agency needs to demonstrate leadership in greenhouse gas emission reductions and provide assistance, share information, etc. with others who are seriously working toward greenhouse gas reductions and encourage greenhouse gas reductions.

PRIORITY RECOMMENDATIONS TO REDUCE GREENHOUSE GAS EMISSIONS

1. Maximize energy efficiency and increase renewable energy in the region's power mix
2. Reduce the greenhouse gas emissions of new vehicles sold
3. Reduce motor vehicle miles traveled
4. Protect natural landscapes and forest biomass
5. Increase recycling and composting rates; reduce waste
6. Develop and adopt a climate change policy framework
7. Promote public education and citizen/corporate/government action
8. Encourage local government to act.

1. **Maximize energy efficiency and increase renewable energy in the region's power mix.** The Puget Sound region has a rich history as a pioneer and innovator in energy efficiency. However, the full scope for capturing cost-effective energy savings has yet to be realized. Energy-efficient lights, appliances, and buildings can save electricity more cheaply than new power plants can produce it. Successful utility efficiency programs and building and construction codes have shown that this "saved" energy can be used to meet new demand, providing both a cost-effective energy resource and major reductions in GHG emissions. As well, recent successes in developing renewables such as wind power, demonstrate that the region is poised to accelerate development of renewable energy supplies, build its clean energy industry, and begin to replace carbon-based fuels in the region's existing supply as appropriate. By supporting existing local hydro resources as well as the development of the next generation of renewable energy sources, such as wind, geothermal, biomass, and solar power, the region can avoid increases in the supply of fossil fuel-based electricity and maintain a highly renewable power portfolio. Key actions include:

   - ➔ Develop standards (or other appropriate mechanisms) that promote meeting new load growth with cost-effective energy efficiencies and renewable energy supplies.
   - ➔ Develop standards that support the use of renewable resources when retiring/replacing existing fuel sources.
   - ➔ Enact state energy efficiency standards for selected appliances and products.
   - ➔ Upgrade the non-residential state energy code and improve local level enforcement, training, and education.

2. **Reduce the GHG emissions of new vehicles sold.** The transportation sector accounts for more than half of the Puget Sound's GHG emissions. Improved energy performance from automobiles is critically needed to reduce these emissions. Efforts to accomplish this are needed at the national and state levels. Key actions include:

   - ➔ Actively participate and engage in efforts to urge the federal government to achieve improvements in fuel economy; and
   - ➔ Adopt California Motor Vehicle standards, which will require stricter emission standards for new cars sold in Washington State.[40]

3. **Reduce motor vehicle miles traveled.** Land use development patterns that decrease citizens' dependence on vehicles (especially single passenger trips) and that support the development of transit options are needed to reduce fossil fuel combustion emissions from cars. In addition, personal behavior changes will be necessary and can be influenced by education, price signals and access to alternative transportation means. Key actions include:

[40] Adopting California Motor Vehicle Standards is not a consensus recommendation. The Association of International Automobile Manufacturers did not support adopting these standards. Details regarding the differing perspectives are included in Chapter Six of the report

- ➔ Establish a VMT reduction goal.
- ➔ Aggressively implement a series of transit, land use and demand-side oriented transportation strategies.
- ➔ Incorporate climate change considerations into regional transportation and land use planning.

4. **Protect natural landscapes and forest biomass.** Through photosynthesis trees and other plants convert atmospheric CO_2 to cellulose carbon. In this manner, atmospheric carbon is stored or “sequestered.” The management of timberlands in a sustainable manner and utilization of wood-derived products will yield a net reduction of atmospheric carbon. The rich forest resources of Puget Sound, which are both important living landscapes and biomass sources, need to remain healthy for effective carbon savings.

5. **Increase recycling and composting rates; reduce waste.** Recycling and other source reduction activities help avoid the unnecessary disposal of potentially reusable materials and avoid and/or delay the energy consumption associated with virgin product manufacturing. Waste disposal sites (such as landfills) should be actively managed to both reduce GHG emissions and, where possible, to generate energy alternatives to fossil fuels. Key actions include:

   - ➔ Increase food waste composting and waste wood and mixed paper recovery rates to 45%, 50% and 58% respectively by 2010; and
   - ➔ Increase paper, plastic, metals and other materials recovery rates by 5-20%.

6. **Develop and adopt a Climate Change Policy Framework**. Curtailing GHG emission increases will require significant action across a broad array of sectors and will entail changes in many areas of economic and daily life. For this reason, the CPAC emphasizes the need to develop an explicit ‘GHG reduction’ policy framework that meaningfully incorporates ‘climate change’ and ‘GHG emission reduction’ considerations into the environmental and economic decision-making of governments, businesses, and individual citizens. Key actions include:

   - ➔ Adopt explicit goals and timetables for GHG reductions; and
   - ➔ Develop a national or regional GHG cap and trade program, or other mechanism to effectively harness the market to efficiently limit and reduce GHG emissions.

7. **Promote public education and citizen/corporate/government action**. Bringing about the change that fundamentally reduces the GHGs that Puget Sound communities emit will require significant change in many human behaviors. Broad-based educational efforts about the issue of global warming and the need for such sweeping change will be crucial to the successful implementation of the CPAC’s other recommendations. A key action in this arena is to:

- ➔ Develop a two-part education approach focusing on (1) a broad-based education and outreach campaign and (2) key messages and lessons for specific audiences.

8. **Encourage local government to act**. Local governments can and should take significant steps to contribute to reducing GHG emissions. (Puget Sound regional businesses, in addition to local governments, can also take action and should be encouraged to do so.) Local governments can influence GHG emissions in several ways including:

   - ➔ leading by example;
   - ➔ creating partnerships and leverage existing opportunities;
   - ➔ advocating for GHG emission reduction actions;
   - ➔ providing technical assistance, funding and incentives and regulation

KEY ACTION ITEMS WITHIN PRIORITY RECOMMENDATIONS

Table 2 summarizes the potential emissions reductions and costs/benefits associated with the key actions identified above.[41] The estimates indicate that the CPAC's recommendations can reduce Puget Sound GHG emissions back to 1990 levels and boost the region's economy between $1.4 billion-$2 billion over the next 15 years.[42]

[41] Adopting California Motor Vehicle Standards is not a consensus recommendation. The Association of International Automobile Manufacturers did not support adopting these standards. Details regarding the differing perspectives are included in Chapter Six of the report.

[42] These estimates are based on Northwest specific data, using widely accepted analytic methodologies that have been replicated in many other places and studies. The cost analysis considers the direct costs associated with incremental technology investments, fuel provision, and, in some cases, program implementation. These estimates reflect widely used net present value cost analysis. (Please see Footnote 67 regarding cost savings associated with adopting California Motor Vehicle standards,) They do not reflect macroeconomic analysis, which would aim to capture more complex economic interactions, including the impacts of changes in consumer prices, local investments, and the re-spending of fuel and electricity cost savings on the local economy.

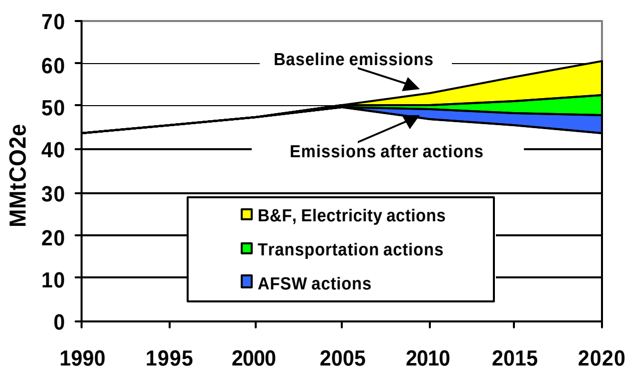
Table 2: Summary of Key Actions, Reductions, and Costs/Benefits[43]

Key Actions	GHG Savings (MMTCO2e) 2010	GHG Savings (MMTCO2e) 2020	Net Costs (million 2002$) 2010	Net Costs (million 2002$) 2020	Net Costs (million 2002$) NPV 2005-2020
Develop and adopt a climate change policy framework					
Emissions Trading (Cap and Trade)	0.2	0.8	16.6	4.1	18.0
Maximize energy efficiency					
Full, sustained efficiency programs, building codes, and appliance standards	1.4	3.5	($55)	($137)	($707)
Other strategies to increase efficiency improve design, and reduce emissions	0.7	1.8	$17 to ($5)	$32 to ($11)	$204 to ($66)
Increase renewable energy in the region's power mix.					
Renewables Portfolio Standard	0.6	1.9	$16 to ($1)	$33 to ($33)	$171 to ($72)
Increase the GHG emissions of new vehicles sold					
Adopt California standards (LEV II and Pavley)	0.2	3.1	($10)	($439)	($1,171)
Other Transportation Strategies	0.1	0.1	not estimated		
Reduce motor vehicle miles traveled					
Location-efficient plans, transit, and demand-side measures	0.5	1.6	not estimated		
Protect natural landscapes and forest biomass					
Landscape Protection	0.8	0.8	$6 to ($6)	$6 to ($6)	$59 to ($59)
Other AFSW Strategies	0.9	2.0	$0.1	$0.1	$1
Increase recycling and compost rates; reduce waste					
Recycling and waste reduction	0.6	1.0	not estimated		
Total	**6.0**	**16.6**	($9) to ($60)	($501) to ($621)	($1,425) to ($2,056)

** Net benefits (negative costs) are shown in parentheses above*

Figure E below displays the potential impact of the recommended actions on the region's projected GHG emissions.

Figure E: Puget Sound GHG Emissions, 1990–2020, Before and After Key Action Items



[43] Net present value, 5% real discount rate. Emissions savings have been estimated for some, but not all, of these other strategies. Furthermore, costs have been estimated for only a few and are thus shown in italics, since they are incomplete. The cost range shown for the RPS reflects differing assumptions about the fate of the federal production tax credit. See Appendix H for a more detailed breakdown by recommended key actions. Also see Footnote 67 regarding cost savings associated with adopting California Motor Vehicle standards,

ECONOMIC CONSIDERATION AND IMPLICATIONS

As noted above, implementation of the CPAC's recommendations will likely result in a significant net economic benefit (from $1.4 to $2.0 billion over the next 15 years).[44] While the economic benefit can better be determined after the recommendations are fully developed and actually implemented, the estimates presented here are based on northwest specific data, using widely accepted analytic methodologies that have been replicated in many other places and studies.

Many of the recommended actions will require a variety of investments across sectors and by a wide array of individuals, businesses and governments. Although the size of the specific investments and timeframe for realizing a return on them varies, they appear to yield a significant economic benefit to the region over time. For example, the energy savings embodied in the CPAC's energy efficiency recommendations alone would deliver approximately $707 million to the region's economy by 2020. To illustrate, Seattle City Light estimates that between 1977–2003, customers participating in its energy conservation program have saved over $369 million on bills. In 2003 alone, City Light conservation customers reduced their bills by $59 million.

Furthermore, the transformation of the region's economy, and the economy of the rest of the world, offers great potential for competitive marketing of the technologies[45], goods and services developed in the Pacific Northwest and needed to support and achieve significant GHG reduction. Although the United States decided not to ratify the Kyoto Climate Change Treaty, many of the region's international trading partners and their host countries have embraced Kyoto and/or its goals and are now investing in actions to respond to climate change. The region's industries will need to anticipate and respond to these market signals to stay competitive. For example, it is expected that the world-wide market for clean energy over the next twenty years will be $180 billion/year.[46] The CPAC suggests that serious thought be given as to how to align the region to take advantage of this large, emerging market.

Another important factor to consider when looking at the regional economic benefits of the CPAC's recommendations is the avoided costs from reducing the impacts of climate change. As discussed above, the CPAC's recommendations represent a solid first step in ensuring that central Puget Sound is helping lessen the impact of climate change. The cost of failing to

[44] The cost analysis considers the direct costs associated with incremental technology investments, fuel provision, and, in some cases, program implementation. For the electricity efficiency strategies, for example, the annualized incremental costs of the more efficient technology were considered and compared against the annualized benefits of avoiding marginal sources of electricity generation, transmission, and distribution. These costs estimates were taken from the Northwest Power and Conservation Council. In the case of Pavley GHG emissions standards,we relied on the California Air Resources Board analysis. To the maximum extent possible, the analyses relied on cost and price estimates from local and regional agencies. It is important to note that these estimates reflect straightforward and widely used net present value cost analysis. They do not reflect macroeconomic analysis, whichwould aim to capture more complex economic interactions.

[45] Specific technologies that offer potential for further development include those associated with wind and biomass energy sources, as well as in fuel cells and photovoltaics.

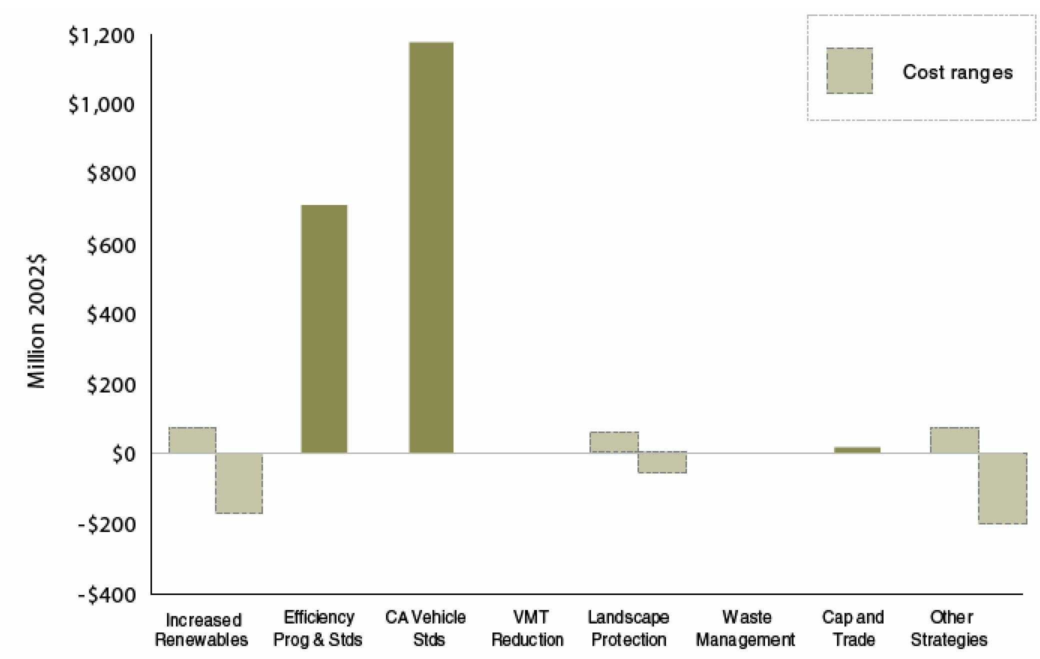
[46] Climate Solutions. Poised for Profit – Clean Energy. http://www.climatesolutions.org/pubs/pdfs/CleanEnergyReport.pdf (Cited October 30,2004)

achieve climate stabilization globally, while not yet quantified, will exceed any short-term costs of central Puget Sound doing its part by reducing its GHG emissions.

Finally, it is worth considering from an economic perspective why it may be difficult to implement the CPAC's recommendations in the short run. A primary reason is that the impacts from emitting carbon into the atmosphere—the costs to the environment and the costs to society from changing the climate—are not yet reflected in the prices we pay for the goods and services that emit carbon. Until this is done on a uniform and rational basis, through a Cap and Trade program or other such mechanism, the cost of making the necessary investment to reduce these emissions falls upon the individual decision-maker, be they utility operator, car owner, developer or government official. Those decision-makers do not yet see market signals that include costs of carbon emission impacts, and hence may have a difficult time seeing the 'benefits' of doing the right thing if everyone else is not required to do so as well.

The transition toward an economy that emits significantly fewer GHGs will not be 'free.' The CPAC acknowledges and recommends that additional analysis be undertaken to identify potential economic dislocations and to craft specific implementation actions that minimize these upfront costs and realize the economic benefits as quickly as possible.

Figure F: Net Present Value Benefits of Key Action Items, 2005–2020



** See Footnote 67 regarding cost savings associated with adopting California Motor Vehicle standards*

SETTING TARGETS AND STRETCHING TOWARDS GOALS

Current scientific data suggest that without explicit intervention, regional GHG emissions will continue to increase. The region's emissions rose 8% from 1990 to 2000, and are projected to increase to 21% over 1990 levels by 2010 and 38% over 1990 levels by 2020. The CPAC has already identified specific actions that can reduce the region's emissions to 1990 levels by 2020. This achievement should not be perceived as a GHG emissions reduction goal, but rather as an initial step toward accomplishing the significant long-term GHG emission reductions that are needed to help stabilize the planet's climate.

The CPAC acknowledges what other jurisdictions have done to set interim and long-term numeric goals for GHG reductions. (See *What Other Jurisdictions Are Doing*.) The CPAC further recognizes that Washington Governor Locke has announced an interim state-wide GHG emission reduction goal of getting back to 1990 levels by 2010 and achieving a 10% reduction from 1990 levels by 2020. Other efforts, such as the New England Governors/Eastern Canadian Premiers effort, also set an interim goal of at least a 10% reduction of GHG from 1990 levels by 2020, and a long term-goal of 75-85% below 2001 levels, the reductions estimated by current science as necessary to eliminate any dangerous threat to the environment.

Over the course of its deliberations, the CPAC highlighted two numeric milestones on the way toward the ultimate goal of climate stabilization: turning the emission curve downward by 2010 and achieving the 70-80% reductions required for climate stabilization by 2050. The CPAC also believes that establishing numeric milestones on the way to climate stabilization has significant leadership merit and urges the CAA to set such goals and targets.

The CPAC recommends that the CAA consider several principles when setting GHG emission reduction goals:

- Establish climate stabilization as the ultimate goal;
- Recognize that the science necessary to set such a goal numerically may change over time;
- Prioritize actions to help "crest the hill" quickly, so that absolute emission levels begin to decline by 2010;
- Accelerate the pace of reductions whenever possible and as new opportunities beyond the recommendations of the CPAC emerge;
- Establish goals that reflect the region's desire to be competitive with the rest of the world's efforts to tackle this challenge.

The CPAC fully recognizes that additional actions will be necessary to achieve long-term climate stabilization and recommends that an overall climate change policy framework (priority recommendation six, above) be established to assure continuing diligent attention to this issue. The CPAC also encourages the CAA to initiate, at appropriate intervals, additional stakeholder efforts or other methods to identify additional GHG reduction strategies based on new data, technology, and opportunities.

The next several chapters of this report examine each of the priority recommendations and the key action items that support those priority recommendations, including any limitations or considerations associated with the individual strategies. These chapters and corresponding priority recommendations are:

Chapter Five: Buildings, Facilities and Electricity Supply

- ➔ Maximize energy efficiency and increase renewable energy in the region's power mix.

Chapter Six: Transportation

- ➔ Reduce the greenhouse gas emissions of new vehicles sold.
- ➔ Reduce motor vehicle miles traveled.

Chapter Seven: Forestry and Agriculture

- ➔ Protect natural landscapes and forest biomass.

Chapter Eight: Solid Waste

- ➔ Increase recycling and composting rates; reduce waste.

Chapter Nine: Climate Change Policy Framework

- ➔ Develop and adopt a climate change policy framework.

Chapter Ten: Education

- ➔ Promote public education and citizen/corporate/government action.

Chapter Eleven: Local Government

- ➔ Encourage local government to act.

5. BUILDINGS, FACILITIES, AND ELECTRICITY SUPPLY SECTORS

PRIORITY RECOMMENDATION

› **Maximize energy efficiency and increase renewable energy in the region's power mix.**

BACKGROUND

Buildings, facilities and electric supply are responsible for nearly 40% of Puget Sound's current GHG emissions (18.6 $MMtCO_2e$ in 2000). Over half of these emissions, or 10.7 $MMtCO_2e$, are emitted directly from on-site fuel combustion.[47] The remaining emissions, 7.9 $MMtCO_2e$ come from the power plants that supply the electricity used in Puget Sound. Each of these sources is expected to grow in significance in the coming decades; together, they are likely to account for over half of the projected emissions growth in the region through 2020.

Although the region is blessed with abundant, inexpensive hydroelectric resources,[48] regional hydroelectric resources are limited and are at risk from the long-term impact of climate change itself, as well as the near-term uncertainties of relicensing and other restrictions that reduce potential hydroelectric capacity or project economics to the point of closure. Given these existing risks and the limited potential for hydroelectric expansion, the amount of natural gas and coal-based power may grow, absent efforts to significantly increase energy efficiency and/or protect and increase renewable energy.

Historically, the region has been a national leader in energy efficiency. Nonetheless, significant opportunities exist to further increase efficiency in the use of electricity, natural gas, and other fuels.[49] These efficiency improvements can provide direct cost savings to households and businesses, and broader benefits to the Puget Sound economy as fuel savings are re-directed to local goods and services.

New, renewable energy sources can also provide an important contribution to reducing the region's future use of fossil fuel resources while providing a host of potential economic and

[47] Other emission sources include industrial processes like cement and lime production, methane emissions from natural gas systems, and, increasingly, the release of high warming potential gases (HFCs) from refrigeration and related equipment.

[48] Emissions from electricity used in Puget Sound are far lower than the national average on a per kilowatt-hour basis.

[49] While considering the recommendations below, the CPAC recognized the previous and continuing efforts to establish energy policy at the state-wide level that could accomplish much of what the CPAC is recommending.

environmental benefits. Just as the region's hydroelectric dams provided a renewable resource that has enabled economic growth with few GHG emissions in the 20th century, wind, geothermal, solar, and biomass resources could play a similar role in the 21st century. Increasing the penetration of renewables can increase resource diversity, lower risk of future energy price volatility, reduce fuel imports and expenditures, facilitate the development of low-emission technologies in the near and long-term, and potentially create regional jobs and economic growth via technology development.

The pursuit of strategies designed to reduce electricity and fossil fuel use and to increase the contribution of renewable energy sources, holds the potential for significant economic benefits in addition to significant emissions reductions. The buildings, facilities, and electricity supply actions recommended by the CPAC could result in emissions savings of 7.9 $MMtCO_2e$ and net cost savings of $0.3 to $0.8 billion through the year 2020 based on net present value basis (NPV).[50]

MAXIMIZE ENERGY EFFICIENCY AND INCREASE RENEWABLE ENERGY

Key Action Items for Utilities:

1. Meet new load growth with cost-effective energy efficiencies and renewable resources.
2. Decrease existing greenhouse gas emissions when retiring/replacing existing fossil fuel sources.
3. In conjunction with key stakeholders, develop standards (or other appropriate mechanisms) and pace for achieving key action items one and two above.

As noted, the CPAC recommends that the long-term goal be climate stabilization. All sectors, public and private entities, will need to participate in the effort to reduce greenhouse gas emissions sufficiently to contribute to meeting this goal. Given the importance of the utility sector in terms of providing the region now with clean hydro power, its current and potential future GHG emissions, and the many proven as well as emerging low-emission technologies, utilities are and can continue to play an essential role in the effort to achieve climate stabilization. The CPAC recommends that the utility sector should reduce emissions over time to levels needed to support the pursuit of climate stabilization. In order to do so, the CPAC recommends that utilities, in coordination with the State of Washington, adhere to the following principles:

[50] The net cost savings are based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs. The range shown reflects alternative assumptions regarding the continuation of the federal production tax credit for renewable energy sources, and natural gas costs for combined heat and power sources. All NPV analyses here use a 5% real discount rate.

- ➔ Begin to contribute to the CPAC's stated objective of reversing the region's current trend line of increasing emissions by 2010, by meeting new load growth through expanded investments in cost-effective energy efficiency and renewables.
- ➔ Acquire additional cost-effective energy efficiency and renewable resources over time as the current fossil fuel inventory is replaced or retired in order to reduce the current inventory of greenhouse gas producing fossil fuels. Where cost-effective energy efficiency and renewable resources cannot replace fossil fuel sources as they are retired, mitigate for CO_2 emissions. Aim for steady, significant reductions over time toward levels consistent with climate stabilization over the long term.
- ➔ Develop with stakeholders and support legislative enactment of appropriate mechanisms such as integrated resource planning, energy efficiency and/or renewable portfolio standards and investment standards to provide pace and structure to accomplishing the above. In doing so, the highest priority should be placed on capturing all cost-effective energy efficiencies. The CPAC process has identified major issues (see below) that must be addressed in developing such mechanisms and recommends that they be resolved so that standards can be established. Key stakeholders should continue to meet to resolve these issues and develop a proposal for the Washington State Legislature by the end of 2005.
- ➔ The major issues identified by the CPAC include: ensuring that options are available for utilities with an expected surplus of electricity resources; developing a common definition for renewables, including a common multi-state definition similar to California's; making incentives available for all qualifying utilities, including facility siting and cost-effective transmission line development for renewable resources; providing flexibility to utilities regarding resource decisions, providing credit for previous investments in renewables and efficiencies; recognizing the regulatory authority of local utility governing boards and retaining appropriate local utility board control; identifying potential mitigation options for GHG emissions; and, considering establishing and using a quantified value/cost for evaluating carbon risk in future energy sources when doing Integrated Resource Planning, recognizing that IRP must be cost-effective and produce diversified portfolios.

  - o Technical analyses for the CPAC process indicate that mechanisms to support energy efficiency (Energy Efficiency Portfolio Standard, Public Benefit Charge Fund, or others) would result in approximately 3.1 $MMtCO_2e$ in avoided emissions by 2020, more than any other single strategy considered by the CPAC. Furthermore, the supporting analysis found that these programs could save the region over $100 million per year by 2020, and over $500 million on a cumulative NPV basis.
  - o The analyses also indicate that a Renewable Portfolio Standard (or alternative target or mechanism) could reduce GHG emissions by 1.87 $MMtCO_2e$[51]. The cost impacts from these two scenarios ranges from a net benefit of $72 million

[51] These potential savings and cost numbers are based on a renewable target of 5% by 2010, 10% by 2015 and 15% by 2023

(PTC through 2020) to a net cost of $171 million (no PTC) on cumulative NPV basis through 2020.[52]

➔ Work with other jurisdictions and interests to support adoption of a national cap and trade system and participate in discussions to explore options for implementing or participating in a subnational cap and trade system (or equivalent carbon content standard). The CPAC reserves judgment on whether a subnational cap and trade approach is workable, and notes that a cap and trade system must cover a large enough geographic area to be workable. (See Chapter Nine for further discussion on the issues surrounding Cap and Trade.)

MAXIMIZE ENERGY EFFICIENCY

Non-Utility Key Action Items:

1. Enact proposed state standards for selected appliances not covered by federal standards.
2. Upgrade the non-residential state building code and improve local level enforcement, training and education.

The CPAC recognizes that non-utility actions are also critical to achieving energy efficiencies and recommends the following key non-utility action items.

1. Appliance Efficiency Standards

The State of Washington should enact state standards for selected appliances not covered by federal standards. As noted by the West Coast Governor's Global Warming Initiative, minimum performance standards are the least-cost way for states to insure cost-effective improvement of the energy efficiency of buildings and the equipment and appliances used in buildings.[53] While federal standards do exist for some appliances, adoption of statewide appliance codes for other appliances without standards such as torchiere lamps, unit heaters, dry-type transformers, traffic signals, exit signs, commercial refrigerators/freezers, digital converter boxes, ice makers, external power supplies, commercial clothes washer, dehumidifiers, BR & ER reflector lamps, digital cable, and

[52] It is challenging to discern the cost impacts of this level of renewable resource acquisition given uncertainty in future electricity supply costs and the fate of the federal Production Tax Credit (PTC) for renewable electricity generation. If the PTC were to be renewed through 2020 (the most realistic scenario), it is likely that acquiring 450 aMW from renewables would be less costly than from other new resources. However, without the PTC, renewables are likely to cost more.

[53] West Coast Governors' Global Warming Initiative, Working Group Four, "Codes and Standards," 13 April 2004 Draft, <http://www.energy.ca.gov/global_climate_change/westcoastgov/documents/2004-04-15_draft_reports/2004-04-19_EFFICIENCY.PDF> (cited 25 October 2004).

satellite boxes. would result in emissions savings of about 0.3 $MMtCO_2e$ in 2020, with a cumulative NPV cost savings of over $150 million through that year.

2. Building Code Changes, Training and Enforcement

Upgrade the non-residential state building code (e.g., for lighting, building envelope, and mechanical systems) and improve local level enforcement, training, and education.[54] This strategy links two key components, upgrades to the existing building code and training of building officials and improved code enforcement. The CPAC stressed that both components are required to achieve the maximum benefit from this strategy. Improvements to the statewide non-residential building code alone would result in a reduction in GHG emissions of 0.04 $MMtCO_2e$. Furthermore, code improvements provide economies of scale for builders and suppliers, and avoid "lost opportunities" for efficient design and operation once buildings are constructed. Importantly, these emissions estimates do not include greater savings that might accrue from enforcement, training, and education to ensure compliance with current and future standards.

ADDITIONAL BUILDINGS/FACILITIES ACTIONS

The CPAC recommends the following additional strategies for further increasing energy efficiency in the Puget Sound region. A number of parties in the region, notably the Northwest Power Planning Council (NPPC), have examined the magnitude and source of cost-effective energy efficiency resources. The following list of actions, (and the actions listed in Appendix M), represent a number of measures and programmatic approaches that could be implemented to capture efficiencies. The list is not prioritized or as in-depth as the NPPC's analysis in its 5th Power Plan. (More detailed information on the recommendations below can be found in Appendix I.)

1. Convert domestic electric water heaters to natural gas.
2. Develop non-utility incentives for low GHG-design and practices in new commercial and residential construction.[55]
3. Promote use of wood as a preferred building material as a means to sequester carbon (see Forestry Sector chapter) and displace more intensive GHG- producing activities.[56]
4. Identify and develop incentive programs to address emission reduction opportunities in cement production and use (e.g., encourage greater use of blended cements).

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[54] The West Coast Governors' Initiative is also considering building code improvements.

[55] In addition to design, this and the following strategy could focus on minimizing GHG emissions during the manufacture or transport of construction materials and/or the construction process itself. Encouraging builders to minimize waste construction materials may be another important action. Possible incentives for builders/developers include density bonuses, Floor Area Ration bonuses, expedited permitting, and low -interest loans.

[56] Especially if the wood can be harvested from local, sustainably-managed forests.

5. Develop non-utility incentives for high-efficiency equipment and retrofits, including providing tax credits or other benefits.
6. Develop programs to train commercial building operators to reduce fuel and electricity use in existing buildings.
7. Develop training programs to assist industry in improving operation and maintenance of existing industrial equipment.
8. Recommission commercial buildings by identifying system operating, control, and maintenance problems in existing buildings;
9. Improve energy efficiency at water, wastewater treatment plants, and public works;
10. Improve energy efficiency in new and existing buildings operated by government entities. In conjunction with efforts to improve efficiency, identify government efficiency goals and report efficiency impacts.
11. Reduce HFC use and leakage through use of alternative refrigerants and improved management practices.

ADDITIONAL ELECTRICITY SUPPLY ACTIONS

The CPAC recognizes that there are other potential opportunities for GHG emission reductions from the electricity supply sector that are beyond the operation of the utilities themselves. To explore those opportunities, **the CPAC recommends the following additional strategies to increase the amount of renewables in the region's overall energy supply.** (More detailed information on the recommendations below can be found in Appendix J, Electricity Supply Technical Memo)

1. Support activities to create more Combined Heat and Power (CHP) opportunities (e.g., through establishment of interconnection standards, appropriate tariff structures, output-based environmental regulations that reward efficiency benefits, tax credits/exemptions, and accelerated depreciation, inclusion of CHP in portfolio standards or incentives directed through public benefit funds).[57]
2. Support the capacity and flexibility of our existing hydroelectric resources, with the understanding that decreases in these resources, especially in the Puget Sound basin, will most probably correspond to development of replacement resources that emit GHGs.
3. Evaluate other actions that would increase the contribution to renewables including converting landfill CH_4 to electric power, installing centralized manure digesters, and using biomass for electric production. These strategies were considered by the Agriculture, Forestry and Solid Waste TWG and can be found in the Forestry/Agriculture and Solid Waste

[57] CHP has the potential to provide 0.79 MMtCO2e in GHG savings by 2020. Cost impacts will depend upon the price paid for natural gas. If CHP applications pay the wholesale cost currently paid by utilities and large users, there could be cost savings of $66 million on a cumulative NPV basis through 2020. However, if their average c ost of gas is more similar to average commercial and industrial costs, this strategy would likely not be cost-effective, presenting a net NPV cost of $204 million through 2020. Potential CHP applications will likely span a spectrum from cost-effective to somewhat costly – further analysis is warranted. Note that not all CPAC members supported this strategy due to the need for further analysis to support potential savings estimates and the potential for CHP projects to increase air pollutants in the local Puget Sound airshed.

Sections of this report. (More detailed information on these strategies can be found in *Appendix J, Electricity Supply Technical Memo and Appendix L Agriculture/Forestry/Solid Waste Technical Memo*)

6. TRANSPORTATION SECTOR

PRIORITY RECOMMENDATIONS

› **Reduce the greenhouse gas emissions of new vehicles sold.**

› **Reduce motor vehicle miles traveled.**

BACKGROUND

The transportation sector represents approximately 50% of the Puget Sound region's GHG emissions.[58] Emissions from transportation sources are projected to grow 24% by 2020 if no action is taken. Although this sector contributes the highest amounts of GHG emissions in the region, the strategies provide significant reductions and could help relieve other regional problems such as congestion, air pollution, and urban sprawl.

The greatest source of emissions from the transportation sector is on-road motor vehicles, representing approximately 74% of the overall transportation sector emissions in 2020. The vast majority of sector emissions are from light-duty vehicles (i.e., passenger cars and trucks), which account for just under 60% of transportation GHG emissions, with heavy-duty vehicles (i.e., diesel trucks) making up the remainder of on-road sources.

REDUCE THE GHG EMISSIONS OF NEW VEHICLES SOLD

Key Action Items:

1. Actively engage in efforts to urge the federal government to achieve improvements in fuel economy.
2. Adopt the California Motor Vehicle standards state-wide.[59]

[58] Transportation sector sources include cars, trucks, buses, aircraft, construction equipment, recreational vehicles, boats and ferries.

[59] Adopting California Motor Vehicle Standards is not a consensus recommendation. The Association of International Automobile Manufacturers did not support adopting these standards.

Two distinct key actions are targeted to reduce GHG emissions from the transportation sector: advocate as a region for the Federal government to adopt improved fuel efficiency standards and support actions by the State of Washington to adopt California's motor vehicle emission standards. These two actions are presented below.

1. Federal Fuel Efficiency Standards

The CPAC supports immediate federal action to achieve improvements in fuel economy and recommends that the Clean Air Agency actively work with the state and others to urge the federal government to adopt improved standards.

CPAC members agree that strengthening the federal standards on average fuel economy offers the most promising approach for achieving GHG emission reductions from automobiles and light duty trucks, such as Sport Utility Vehicles (SUVs). Because motor vehicles are such a significant contributor to GHG emissions nationwide, the United States as a whole needs to begin to take action immediately to reduce their emissions.

2. Adopt California Motor Vehicle Standards

All of the CPAC members, except for the Association of International Auto Manufacturers, recommend that the State of Washington adopt California Motor Vehicle standards.

The federal government is generally responsible for establishing national emission standards for new motor vehicles.[60] However, in some instances, California's Motor Vehicle Program is allowed to set motor vehicle requirements that may be stricter than the federal standards. As an alternative to federal vehicle emission standards, Section 177 of the Clean Air Act permits other states to adopt California's vehicle standards if they exceeded federal air quality standards in 1990.[61]

All of the CPAC members, except for the Association of International Auto Manufacturers, recommend that Washington State opt into the California vehicle program, which consists largely of two key components:

a. California's Low Emission Vehicle (LEV II) Standards.
b. Pavley Motor Vehicle standards.

[60] In 2004, Federal Tier 2 emission standards went into effect. These Tier 2 standards require stricter tailpipe and evaporative emissions controls in new passenger cars and light duty trucks than the previous federal standards.
[61] The Puget Sound Clean Air Agency legal staff believe that Washington State meets this requirement and hence is eligible to adopt the California program. Specifically, Washington has two non-attainment areas, Yakima and Spokane, and two large regions, Seattle and Vancouver that are now Maintenance Plan areas.

Each component is briefly described below.

LEV II

California LEV II Standards consist of two parts – a low emission vehicle (LEV) component, which requires 90% of new cars and light duty trucks to meet stringent emission limits and a zero emission vehicle (ZEV) component which requires 10% of new vehicles to meet even stricter pollution limits, including zero evaporation limits.[62] The ZEV requirement may be met with partial ZEVs (or PZEVs), such as hybrid electric vehicles and other advanced technology vehicles. The LEV II program reduces nitrogen oxides, hydrocarbons, and carbon monoxide. It is not specifically designed to reduce GHG emissions; however, there is a small GHG reduction because of the 10% ZEV requirement. The technical analyses supporting the CPAC process indicated that implementation of LEV II standards would reduce transportation GHG emissions by less than 1% or 0.14 $MMTCO_2e$ in 2020. This number assumes that the Puget Sound region will meet the ZEV requirement through a combination of hybrid-electric and other ZEV-certified vehicles.

Pavley Motor Vehicle Standards

California is developing regulations to reduce GHG emissions from motor vehicles. By January 1, 2005, the California Air Resources Board (CARB) is required to develop and adopt regulations that achieve the maximum feasible and cost-effective reduction of GHG emissions from passenger vehicles and light-duty trucks.[63] CARB has analyzed technology packages that address the GHGs from motor vehicles, including both tailpipe emissions and refrigerant emissions. The regulations are to go into effect in January 2006 and will apply to motor vehicles manufactured in model year 2009 and thereafter.[64] The technical analyses supporting the CPAC process indicated that implementation of these standards (known as the Pavley standards) could reduce Puget Sound transportation sector emissions by 10% or 2.96 $MMtCO_2e$ in 2020. This would result in a 17% overall reduction in GHG emissions from Puget Sound light-duty vehicles by 2020.[65]

Table 3: Summary of California Vehicle Standards Costs and Benefits in 2020

California Vehicle Standards	**2020 Emissions** *($MMtCO_2e$)*	**2020 $/MtCO$_2$e** *(cost effectiveness)*	**Net Benefits 2020** ('000)	**NPV (2005 -2020)** (millions)
Low Emission Vehicles (LEVII)	0.14	$14	($456)	$4
GHG Tailpipe Standards (Pavley)	2.96	($126)	($438,900)	($1,175)
Total	**3.10**	**($112)**	**($439,356)**	**($1,171)**

[62] As defined by California Air Resources Board, zero emission vehicles are vehicles which produce no emissions from the on-board source of power (e.g., an electric vehicle)

[63] AB 1493, signed August, 13, 2002 (www.arb.ca.gov/cc/ab1493.pdf).

[64] CARB is also to provide flexibility, to the maximum extent feasible, in terms of complying with the regulations. CARB must ensure that any alternative methods for compliance achieve equivalent or greater reduction in GHGs.

[65] This was based upon a rate-base vehicle analysis from CARB that estimated the average reduction in GHGs from new cars (vs. current vehicles) would be 22 percent in 2012 and approximately 30 percent in 2016 and assumes the Assuming Pavley regulation takes effect in mode year 2009. For more information, see http://www.arb.ca.gov/newsrel/nr092404.htm

Key Issues Regarding California Motor Vehicles Standards

All CPAC members, except for the Association of International Automobile Manufacturers, support state adoption of the California Motor Vehicle standards. This single action, in particular the Pavley standards described above, produces a significant amount of the emission reductions estimated for all of the recommended actions combined, second only to the energy efficiency recommendations. (3.1 $MMTCO_2e$ versus 3.5 $MMTCO_2e$ respectively.) It also accounts for a significant amount of the financial benefits estimated for the collection of recommendations in this report. A brief summary of the CPAC's recommendation and the opposing view are included below.

Majority View—Adopt California Vehicle Standards in Washington

With transportation accounting for half of the Puget Sound's GHG emissions and more cars entering the region, meaningful progress toward lower GHG emissions is not possible without better vehicle technology. Adopting California State standards is the most straightforward means to achieve that goal through state action. Adoption of California standards would deliver:

- **Significant reduction in the region's global warming pollution and toxic air emissions.** California standards would yield a 17% reduction in fleet-wide transportation global warming pollution by 2020 in the Puget Sound region.[66] They would also reduce conventional air pollution and cancer-causing air toxics such as benzene and formaldehyde.
- **Large and sustained economic benefits to the region and to vehicle owners.** The value of aggregate savings would exceed $1 billion by 2020. A purchaser of a new car financed over 5 years would reap net savings of $11 per month due to fuel savings, after subtracting for additional capital costs.[67]
- **Technology and consumer benefits.** Vehicles that meet the current California LEV II standards have much longer warranties (up to 10 years and 150,000 miles) on emission control equipment to ensure clean performance over time. Pavley

[66] By 2020, the average new vehicle sold in Puget Sound will emit 30% fewer GHGs than the same average vehicle does today.

[67] This analysis assumes gas would continue to cost $2 per gallon. Regarding cost effectiveness, Sierra Research testified on behalf of the Alliance of Automobile Manufacturers at the CARB September Board meeting that the CARB cost-effective analysis was incorrect because it did not adequately account for manufacturing costs due to issues such as research and development, the ability of manufactures to add new technologies to motor vehicles, and assumptions about the mileage accumulated over the lifetime of the vehicle. CARB responded that their assumptions regarding the cost of research/development and warranties were accurate, and that the technologies could be added to new car models with little additional costs to manufacturers. CARB also presented testimony showing an example of the impacts of a lower total mileage assumption. The results indicated that their total cost savings would be reduced. However, the savings of the new requirements still outweighed the additional costs. CARB presented an example showing the net present value being reduced from $1472 to $923, for an average vehicle. See California Air Resources Board. Board Meeting Minutes, Testimony for September 24, 2004. Los Angeles, CA. <http://www.arb.ca.gov/board/mt/mt092404.txt> California Air Resources Board. Board Meeting Minutes, Testimony for September 23, 2004. Los Angeles, CA. <http://www.arb.ca.gov/board/mt/mt092304.txt> The cost-effectiveness of California standards remains a subject of debate.

standards will likely increase the availability of popular hybrid car models in Washington, reducing waiting periods and increasing vehicle choice.

- **Implementation issues:** LEV II standards have already been adopted in eight states, and are not currently subject to legal challenge. Administrative requirements associated with the stronger state standards are modest, since the standards must be identical in all of the states that adopt them. This provision reduces both administrative burden and provides manufacturers with assurance that they will only have to meet one uniform state standard, in addition to the federal standards.

Minority View—Federal Standards Only

The Association of International Automobile Manufacturers does not support state adoption of the California Motor Vehicle standards. The design and manufacture of motor vehicles is necessarily a national industry. It is premature for other states to consider the California Pavley standards since California has not completed its adoption or applied to EPA for the necessary approval waiver.[68]

- **Emission reductions**: Potential air pollution benefits associated with the LEV II standards are questionable, as California LEV II reduction estimations are based on the use of California fuels, which are cleaner than fuels currently available in Washington.[69]
- **Costs and Savings:** There are open questions regarding the actual costs and benefits of the Pavley standards being adopted in California. Comments provided to the California Air Resources Board by the auto manufacturers pointed out that its costs projections were vastly understated. Auto manufacturers believe that vehicle costs could rise as much as $3,000 per vehicle, exceeding the value of related fuel savings over the life of the vehicle. (See footnote 67) In addition to the increased costs of vehicles, there are additional burdens/costs for motor vehicle manufacturers, dealers, and the state[70]. In particular, internal administration of different warranties, accounting changes, monitoring of vehicle distribution, state reporting requirements, and other related administrative activities that would be additional costs for the dealers and manufacturers. Washington automobile dealers might also lose revenue if consumers travel to neighboring states that have not adopted California standards to purchase motor vehicles.
- **Technology and Consumer Impacts:** With or without adoption of California standards, Washington consumers will have the option of purchasing a greater

[68] It was noted that section 177 allows other states to consider adoption of California standards only for those standards for which a waiver has been granted by EPA.

[69] Washington already receives some low sulfur gasoline from three refineries. BP supplies about 25% of Puget Sound fuel and produces gasoline with very low sulfur and reduced benzene levels comparable to California fuel, though this fuel does not necessarily meet all of the specifications of California fuels at this point in time. It is anticipated that Washington State will have low sulfur fuels widely available by 2006.

[70] The Washington Department of Ecology estimates that the LEV II program would require one additional staff person for implementation.

variety of hybrid-electric and other advanced technology vehicles in the future. Many automakers have already announced plans to introduce more types of hybrid vehicles in the next several model years, including hybrid SUVs and pickup trucks being introduced in 2005. These models will be sold nationwide just as current hybrid models are. Ironically, one vehicle class, light duty diesel vehicles, which are inherently about 35 to 40 percent more fuel efficient than comparatively sized gasoline vehicles, have not yet been certified to meet California LEV II emissions standards, despite the fact that ultra clean diesels have now been developed.

- **Legal Uncertainties:** There are many outstanding legal issues associated with the Pavley standards; therefore, it would be prudent to wait until those uncertainties are resolved before Washington State considers whether or not to pursue the program. Lawsuits have been filed in both federal and state courts challenging the California motor vehicle greenhouse gas standards.

REDUCE MOTOR VEHICLE MILES TRAVELED

Key Action Items:

1. Establish a VMT reduction goal.
2. Aggressively implement a series of transit, land use and demand side oriented strategies.
3. Incorporate climate change into regional transportation and land use planning.

The CPAC believes that the region must take steps to reduce the number of vehicle miles traveled. Without additional action, the number of vehicle miles traveled is projected to increase by 16.1% in the year 2020.[71] If this growth rate continues, VMT for the Puget Sound region will be 33 billion miles in 2020.[72] To reduce the vehicle miles traveled associated with projected growth, climate-friendly development and a transit backbone are required to serve new residential and commercial developments.[73]

The CPAC applauds the many efforts now occurring in the Puget Sound region to reduce vehicle miles traveled and identified its task as effectively building upon the work that has been done-to-date. The CPAC recognizes that there is no single strategy to achieve the stated goal of reducing VMT; rather, a series of complementary strategies that can have the significant impact needed.

1. Establish a regional VMT reduction goal

[71] Based on the Puget Sound Regional Council's forecast.
[72] Based on the Puget Sound Regional Council's forecast and additional data from PSRC.
[73] Development patterns are also critical to saving existing biomass for purposes of carbon sequestration.

A VMT goal should emphasize the reductions the Puget Sound region would like to achieve within a specified timeframe. The goal would provide a tool against which to measure success.

2. Implement three distinct packages (in Table 4 below), developed around land use-oriented actions, transit-oriented actions, and transportation demand side measures.

Each package is directed towards the primary entities responsible for its implementation and contains specific actions that the CPAC emphasizes. The CPAC urges that that these actions receive priority with respect to funding and development of effective implementation mechanisms. The specific actions are:

- Encourage transit-oriented development;
- Establish parking pricing and supply;
- Improve transit frequency and transit options;
- Expand bike and pedestrian infrastructure; and
- Fully fund current and expanded demand-side transit initiatives.

3. Incorporate climate change considerations into regional transportation and land use planning.

Existing transportation and land use planning forums represent important opportunities to consider the impact of various future actions on climate change. Specifically, the CPAC supports the efforts of the PSRC and its Metropolitan Transportation Plan, *Destination 2030* and believes that the policies identified in the plan will support GHG emission reduction efforts.

Table 4: Key VMT Strategies

Land Use Oriented Strategies (Targets primarily local government and the development community) Implementation would result in an approximately 5% decrease in projected vehicle miles traveled in the year 2020 and a 2.5% reduction in transportation sector GHG emissions or 0.73 million metric tons of CO_2e reduction by 2020.

- ➔ Transit-oriented development. Includes:
  - o encouraging development near existing transit centers
  - o create/meet minimum density standards
  - o locate government buildings in centers
  - o encourage mix of complementary land uses that generate pedestrian activity and transit ridership
  - o Smart Growth planning, modeling and tools
  - o create an incentive program that encourages cluster developments
- ➔ Parking pricing and supply
- ➔ Prioritize infrastructure funding or withhold funding from greenfields
- ➔ Fix it First
- ➔ Infill/Brownfield re-development
- ➔ Location efficient mortgages
- ➔ Targeted open space protection
- ➔ Set urban growth boundaries to meet density standards

Transit Oriented Strategies (Targets primarily local government and transit operators) Implementation would result in an approximately 2% decrease in projected vehicle miles traveled in the year 2020 and a 1% reduction in transportation sector GHG emissions or 0.29 million metric tons of CO_2e reduction in 2020.

- ➔ Improve transit frequency and transit options. Includes:
  - o increasing bus services
  - o addressing bus frequency and quality
  - o park and ride services
  - o vanpools
  - o improve coordination among transit operators
- ➔ Expand bike and pedestrian infrastructure
- ➔ Expand and complete High Occupancy Vehicle lanes

Demand Side Measures (Targets primarily state government) Implementation would result in an approximately 4% decrease in projected vehicle miles traveled in the year 2020 and 2% reduction in transportation sector GHG emissions or 0.59 million metric tons of CO_2e reduction in 2020.

- ➔ Fully fund current and expanded demand-side transit initiatives. Includes:
  - o tax credits
  - o Commuter Choice
  - o telecommuting
  - o car sharing
- ➔ Promote transit pricing incentives
- ➔ VMT tax
- ➔ Pay as You Drive Insurance
- ➔ Congestion pricing
- ➔ VMT offset requirement (E.g., for large developments)

Implementation of the selected measures identified here will reduce VMT by 11% in 2020. When compared to current baseline forecasts, this will result in reduction of just over 3.5 billion miles traveled annually in 2020 in Puget Sound. The CPAC recognizes that reducing VMT will require changes at all levels and lifestyles. CPAC members emphasize the importance of education in helping people make the choices necessary to reduce vehicle miles traveled. A broader discussion on education can be found in Chapter Ten. Specific education components related to transportation can be found in Appendix N.

ADDITIONAL TRANSPORTATION ACTIONS

In addition to the strategies described above, the **CPAC recommends the following actions to reduce emissions from the transportation sector**. (More detailed information on these strategies can be found in Appendix K *Transportation Quantification Memo*)

1. Freight-In-Use Elements: Improve freight traffic, including operation efficiencies, loading optimization and traffic flow. As a specific action, encourage the West Coast Diesel Collaborative to consider climate change as a critical element in its decision-making practices.
2. Renewable Fuels: Encourage new initiatives and support and supplement existing efforts to develop markets for renewable fuels. Bolster public and private sector support for renewables and develop supporting infrastructure.
3. Low-GHG tax, feebate and rebate system as an alternative or prior to adoption of California standards. Use incentives and/or disincentives to influence consumer purchases of motor vehicles; charge a fee on purchases of high-emitting vehicles and provide rebate for purchases of low-emitting vehicles.

4. Low sulfur diesel and black carbon: Encourage/support existing and planned efforts to reduce emissions from diesel vehicles. (*Most CPAC members agree that the science of black carbon is too uncertain at this time to rely on analyses regarding potential GHG emission reductions from use of low sulfur diesel, but support the measure given the clear co-benefits of reducing toxics and particulate matter. Other CPAC members do not support incorporating the strategy as a recommended strategy in light of the scientific uncertainty).*

7. FORESTRY AND AGRICULTURE SECTORS[74]

PRIORITY RECOMMENDATION

› **Protect natural landscapes and forest biomass.**

BACKGROUND

The Puget Sound region enjoys an extensive network of forested lands, parks, and other natural areas. While the AFSW sector is a modest source of GHG emissions in Puget Sound, contributing 11% of GHGs in the region's overall emission inventory, these lands play a vitally important role in reducing the total emission of GHGs to the atmosphere. At the same time, they provide numerous environmental (e.g., sensitive species habitat, water filtration), economic (timber production, agriculture), and social, esthetic, and recreational co-benefits.

Forests, especially when managed appropriately, can store or sequester carbon (both in tree biomass and surrounding organic matter in soils), thereby capturing carbon that might otherwise be emitted to the atmosphere as CO_2. Well-managed forestlands can also increase the amount of biomass available for wood products or energy production, which can further store carbon and reduce the need for fossil fuel based energy sources.[75] Urban forested areas, including parks and stands of trees on or near residential lots, can provide additional climate change/energy efficiency benefits such as summer cooling (by shading buildings) and winter warming (by blocking wind). Finally, forestland protection (or conversion) patterns can work in concert with other land use-oriented actions, and be designed to influence vehicle travel demand and VMT.

The CPAC acknowledges the importance of managing and protecting these natural resources from a climate protection standpoint and strongly supports local governments, land owners, developers, environmental groups, and others to take specific steps to adopt management techniques that maximize carbon sequestration. The CPAC emphasizes actions related to: (1) efficient development location and patterns to maximize tree retention and forest biomass; (2) reduced lot sizes to reduce forest clearing per unit and allow greater protection of carbon sequestration; and (3) on-site timber management to protect forest carbon and maximize carbon storage and energy displacement benefits of wood products and biomass energy.

[74] Please note that for purposes of the emissions inventory, the forest, agriculture and solid waste sectors were combined. Solid waste follows as a separate chapter and the CPAC identified only one agriculture-related action, #5 under "additional strategies" below. For that reason, this chapter focuses almost entirely on forest-related issues.

[75] Active management of forest lands and through sustainable removal of biomass and constructive use of harvested wood products and biomass energy feedstocks can maximize the total lifecycle carbon stored and displaced by both forest and post harvest products.

Over the course of its deliberations, the CPAC discussed setting specific numeric forest retention goals but refrained from doing so, recognizing the need for more data on forecasted rates of land use change, impacts of current growth management actions, and the fact that local governments will need to balance climate protection needs with other environmental and development aims, goals, and commitments prior to setting management targets.

PROTECT NATURAL LANDSCAPES AND FOREST BIOMASS

Key Action Items:

1. Implement a combination of programs to ensure maximum protection and enhancement of Puget Sound forests.

1. Identify and implement a combination of programs[76] to ensure maximum protection and enhancement of Puget Sound forests (including working and private, non-working forests).

The following actions were identified as potential paths for meeting the goal of protection and enhancement. Together, these actions are estimated to reduce Puget Sound GHG emissions by 0.84 MMTCO$_2$e.

- Modify local land use planning requirements to prioritize protection and enhancement of forested lands. Local planning requirements should emphasize forestland conservation and management.
- Establish quantitative forest retention goals to favor those species and stands that provide maximum carbon sequestration, shading, or cooling potential.
- Establish voluntary programs that reward development of individual properties in ways that reduce GHG emissions. This strategy could focus on minimizing the footprint of land cover disturbed for development (e.g., land clearing for homebuilding).
- Design and implement a voluntary program that encourages reduced landclearing through clustering of development (as opposed to uniform, large lots) combined with

[76] The CPAC was especially interested in incentive-based approaches to protect and enhance working landscapes, recognizing that certain regulatory approaches may be challenging to implement in this region, given State Growth Management Act requirements, landowner preferences, and other regulatory and/or political constraints. The CPAC notes that many local governments already have in place programs or strategies that recognize the value of working landscapes and that are designed to discourage conversion and reward retention of working forests and other land types.

protection of forestlands.[77] This action could be implemented in a number of ways, including, through establishment of :[78]

- o A Transfer of Development Rights (TDR) or easement program for the four-county region that permits developers to increase density (or take advantage of other similar development incentives) in urban areas suitable for such clustering. The TDRs and/or easements would come from the rural and forested areas, thus acquiring for perpetuity their ability to store carbon. This strategy has the potential to 'link' urban development with rural and forest conservation to increase development on higher economic value land and to increase carbon storage on lower value lands in a manner that can be win-win for all parties
- o A program focused on rural and forested areas. This approach would, in select instances for specific parcels, enable clustering above current parcel zoning in exchange for securing TDRs, easements or some form of the 'carbon rights' of other parcels in the rural or forested lands. [79]

- ➔ Consider climate change and/or GHG emissions if or as the Growth Management Act is reviewed and/or updated.
- ➔ Consider establishing a carbon exchange program that provides incentives for urban and rural developments to work together to manage for carbon sequestration in exchange for a benefit received.
- ➔ Establish a regional team of local governments, scientists and other representatives to further study and consider the data on rates of land use change (i.e., permanent loss of forest cover), implications of growth management actions, and the balancing of environmental and development objectives.
- ➔ Promote innovative ways to finance forest protection throughout the four-county region. The region has some 830,000 acres of privately-owned industrial forestlands. This resource is capable of storing millions of tons of carbon over many decades, and as such can play a critical role in reducing the region's overall GHG emissions. The CPAC supports ongoing efforts to finance the transfer of ownership of these lands to entities who will maintain them as working landscapes in perpetuity and believes that greater action is needed to provide the necessary protections. The CPAC notes that

[77] Clustering development can reduce landscape disturbance and reduce emissions from vehicle trips to remote locations. Encouraging the clustering of higher density development near available core living and working areas further reduces the distance and dependence upon single occupancy vehicle trips (as discussed in above sections).

[78] The CPAC notes that successful implementation of this type of program requires that some entity be designated and have sufficient resources to monitor and manage the TDRs or easements to ensure that those lands are not developed in the future. The CAA could help local governments establish the ratio of carbon storing potential preserved with the development bonuses offered.

[79] Some of the important issues that would need to be resolved for this strategy to be effective are: which parcels would be eligible for this program; how increased density on these parcels might support the urban growth line and not put additional pressure on it or local services; which parcels' TDRs could be used, either those adjacent to the development parcel and/or throughout the four county region; how to retain forest cover in the parcels that are clustered? Though these issues are difficult, and require some creative thinking about development in rural lands, the CPAC believes this strategy holds great promise in rationalizing rural development, and preserving the ability of rural and forested lands to store carbon, and, ultimately helping to reduce VMT.

alternative finance mechanisms (such as Community Forestry bonds) will be needed to conserve major tracts of this working forestland and recommends that Washington State participate more fully in programs like Forest Legacy[80] that provide federal funding to purchase conservation easements that extinguish development rights while keeping forest land in active timber management. Incentives to reduce land clearing during the development process may also be important tools for forest carbon protection given that land clearing costs are higher for conventional large lot development than for conservation design or new urbanist design of housing sites.

ADDITIONAL FORESTRY/AGRICULTURE ACTIONS

To support and augment the strategies discussed above, **the CPAC recommends the following additional strategies for protecting and enhancing forests and other working landscapes in the Puget Sound region.** (More detailed information on these strategies can be found in *Appendix L Agriculture/Forestry/Solid Waste Technical Memo*).

1. Restore and maintain the ecology of riparian areas in industrial forests.
2. Enhance urban tree and forest resources. Protect existing healthy trees in urban residential areas from premature removal. Increase street planting and maintenance. Protect forest remnants threatened with development in urban cores.
3. Manage smaller (less than 20 acre) private forests actively by replacing hardwoods on five percent of those forested tracts with softwoods, such as Douglas Fir, that have higher carbon sequestration rates. Provide technical assistance and support to those landowners to ensure maximum forest health.
4. Increase the supply of biomass from Puget Sound forests and other energy crops for electric power production.
5. Install centralized manure digester(s) for dairy farm waste to reduce CH_4 emissions from conventional storage of manure and to capture and convert CH_4 to electric power and/or liquid natural gas.

[80] The Forest Legacy Program (FLP), a USDA Forest Service-sponsored program, provides grants to enrolled states to purchase conservation easements or fee acquisition on environmentally important forest lands that are threatened with conversion to non-forest uses. Washington State is one of more than 26 states currently enrolled in the FLP.

8. SOLID WASTE SECTOR

PRIORITY RECOMMENDATION

› **Increase recycling and composting; reduce waste.**

BACKGROUND

Waste reduction, recycling, composting, and other waste management activities can affect GHG emissions in significant ways. As illustrated in Figure G below, these actions can reduce the fuel combustion and other emitting activities involved in extracting raw materials and manufacturing final products. These emissions savings may occur outside the region, but can be important nonetheless. Within the region, waste management activities—such as hauling waste and recyclables and managing landfills to minimize fugitive CH_4 –already add to GHG emissions.

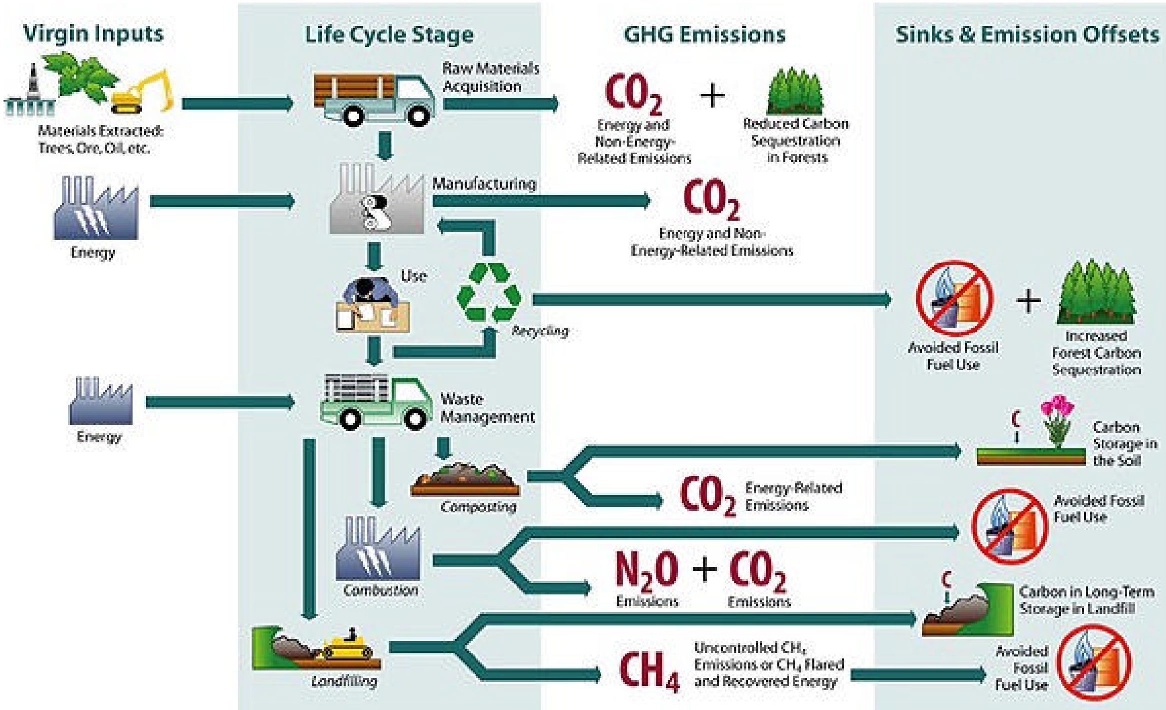
The region has already made major strides in recycling and waste management; nonetheless, the amount of waste going to landfills continues to increase, and less than half of the region's waste is currently recycled. The various county and municipal solid waste agencies in the region have detailed solid waste plans in place or in development and many have recently adopted ambitious goals for waste reduction and recycling. In addition, some are planning or considering numerous initiatives that could greatly increase the amount of waste diverted from landfills, using innovative techniques and targeting waste streams, such as wood and food wastes that currently have low recycling rates.

INCREASE RECYCLING AND COMPOSTING; REDUCE WASTE

Key Action Item:

1. Increase food waste composting and waste wood recovery rates, and increase paper, plastic, metals and other materials recovery rates.

Figure G. Sources of GHGs Emissions and Removal in Product Life Cycles (USEPA) [81]



1. Increase food waste composting and waste wood and mixed paper recovery rates to 45%, 50% and 58% respectively by 2010; increase paper, plastic, metals and other materials recovery rates by 5-20%.

Meeting major new recycling goals for food waste composting, wood and mixed paper recycling (achieve total recovery rate of 45%, 50% and 58% respectively by 2010), along with continued and more modest increases in the recycling of plastic, metals, newspaper, office paper, corrugated cardboard and other traditional recyclable materials (increase 2002 recovery rates by 5-20% by 2010) could yield overall emissions reductions of 0.6 $MMtCO_2$ by 2010 and 1.0 $MMtCO_2$ by 2020.[82] For example, as of 2005, the City of Seattle has banned recyclable items such as yard waste and cardboard from disposal in the garbage. When the

[81] http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWasteBas icInfoGeneralLifeCycle.html

[82] Two scenarios were considered for methane capture at landfills: 75% (higher emission savings) and 90% (lower emissions savings). The technical team used USEPA's Waste Reduction Model (WARM) model[82] to determine the potential emission CO_2e emission reductions from the recommended recovery rate increases. EPA created the WARM to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices. The emission reductions reflect lifetime emissions – including the emissions that would have been required to produce the products, emissions from transporting material to landfills or recycling/composting facilities plus emissions and emission sav ings from landfills.
http://yosemite.epa.gov/oar/globalwarming.nsf/webprintview/ActionsWasteWARM.html

rule is fully enforced (following a year of education and outreach to inform the public about the new rule), garbage that contains a substantial amount of recyclables won't be picked up. The ban on recyclables in garbage is one strategy the City has adopted to increase the recycling rate from the current 42% to 60%. Three east King County cities, including Bellevue and Kirkland, now offer food waste composting for their residential customers.

ADDITIONAL WASTE REDUCTION ACTIONS

Estimated GHG savings from waste management activities are primarily realized through recycling and keeping yard and food waste out of landfills. Additional reductions may be achieved through other waste reduction strategies, some of which are already being implemented by some jurisdictions. **The following strategies hold additional potential for reducing GHG emissions beyond the estimates above**.

- Capture and convert landfill CH_4 to electric power and/or liquid natural gas at all viable facilities across Puget Sound. Many of landfills currently "flare" CH_4. Conversion to electric power or liquid natural gas further reduces the emissions of GHGs and provides a useable, reliable energy source.
- Source reduction (or waste prevention) is defined as the avoidance of waste generation through the reduction in demand for a product, or a reduction in the amount of material a product is made of. For example, double-sided copying or electronic filing can reduce demand for paper. Product redesign can reduce the amount of material contained in a product, such as computers or telephones. By compiling and publicizing source reductions ideas for business and residences and promoting product redesign, significant savings in materials—and in GHG emissions—can be achieved.
  Reuse also contributes to reduced demand. For example, using rechargeable batteries instead of disposables, reusing packing materials, or repairing rather than replacing equipment can also contribute to GHG reductions by reducing demand. Source reduction and reuse not only reduce waste, energy consumption, and materials demand, but they also can save on expenses and on the cost of waste disposal.[83]
- Product stewardship is a concept that links production and use of a specific product with the responsibility to design, produce and dispose of it in a manner that protects the environment. The operating principle in product stewardship is that the entity in the life of a product that has the most ability to affect its design and recyclability has the most responsibility to pay and/or arrange for the product's management at end-

[83] Resource Venture, a non-profit partnership of Seattle Public Utilities and the Seattle Chamber of Commerce, provides publications and consulting assistance to businesses in these areas. In addition, there are many organizations that accept donations of used equipment and products such as office supplies, building materials, and clothing.

of-life. For example, computer companies marketing in Europe are in the process of designing their products to be less toxic, more energy efficient, and more recyclable. These manufacturers include the end-of-life collection, recycling and disposal costs in the prices of the product. This front-end financing method is called cost internalization. Removing the charge from the customer at the time of recycling ensures high recycling rates. This type of producer responsibility also gives manufacturers a financial incentive to design products that are highly recyclable and contain fewer toxins. In the U.S., the USEPA has developed or is pursuing agreements in the fields of electronics, automobiles, carpeting, batteries, and packaging, as well as with products containing mercury. Others are working to develop product stewardship approaches to paint, pesticides, tires, cell phones, and other materials. For instance, rechargeable batteries can now be recycled at locations across the country in a program paid for by a fee that battery manufacturers pay to a “third party” organization of manufacturers that facilitates the collection program. Another example is the Nike "Reuse a Shoe" program, in which old or defective athletic shoes are disassembled and the materials used to make flooring for athletic facilities.

While it is complicated to determine GHG reductions from the above activities, all should be made part of the education program, and should become part of the reduction programs of all levels of government.

9. CLIMATE CHANGE POLICY FRAMEWORK

PRIORITY RECOMMENDATION

› **Develop and adopt a climate change policy framework to support climate change goals and actions.**

BACKGROUND

Climate change is a significant, long-term, critical issue that will have substantial impacts on ecological systems and the economy of the Puget Sound region and Washington State. The significance and nature of the issue really requires that all who contribute to the problem contribute to the solution. To do so effectively will require a broad array of actions across the many different GHG emission sources in the Puget Sound region. A cohesive approach is needed to organize, direct and measure the many efforts to stabilize GHG emissions from the region, the state, and beyond.

The CPAC recommends developing a climate change policy framework that provides coherence and structure to future climate action plans and establishes a systemic, results-oriented response to climate change. The framework is anchored by the following key components.

1. Establish explicit numeric GHG emission reduction goals. These goals can be developed at various levels—state, local, regional—and perhaps for specific sectors, such as a VMT reduction goal for motor vehicles. The goals should put our region at the forefront of the state and local responses to global warming, and enable us to catch up to the international community, which is operating under stronger goals pursuant to the Framework Convention on Climate Change.
2. Commit to specific timetables for meeting those goals and taking specific actions to achieve success.
3. Develop a climate change-centered education program. Extensive education efforts regarding climate change, its impact, and our ability to effect change would be designed to inform and motivate all sectors, including the general public, to make the necessary changes. This education program would be linked to and highlight decision options and solutions so that positive action is the end result of this education. (Please see the following Chapter for a more detailed discussion on education.)

The CPAC endorses the following key objectives for a climate change policy framework.

- Provide a cohesive approach for existing and expected climate change efforts (both statewide and west coast arenas).[84]
- Incorporate climate change into existing broader environmental and economic planning and decision-making forums.
- Create goals against which the region can measure progress and inform decision makers if further action is required.
- Provide certainty regarding the costs for accounting for carbon savings around which government and business can plan and make decisions.
- Help ensure that the region is making its desired and necessary contributions to overall GHG emission reductions.

DEVELOP AND ADOPT A CLIMATE CHANGE POLICY FRAMEWORK TO SUPPORT CLIMATE CHANGE GOALS AND ACTIONS

Key Action Item:

1. Develop a GHG Cap and Trade Program and/or other appropriate market mechanisms to limit and reduce GHG emissions.[85]

The CPAC supports development of a CO_2 Cap and Trade Program, with the caveat that the program be designed at a geographic scale large enough to make practical and economic sense. Specifically, the CPAC recommends that the State of Washington engage in dialogues and efforts occurring throughout the broader U.S. to explore the potential of a Cap and Trade program. In addition, the state should further analyze the issues associated with the design of a Cap and Trade program. For example, the design of a Cap and Trade program needs to address: data sources for consistent tracking of emissions; permit allocation methods; determination of cap levels; geographic scale; administration, compliance and enforcement issues; proper regulatory support and, cost recovery mechanisms, among others. Also, the CPAC recommends that Washington actively participates in carbon market development in the Western United States to maximize the potential economic returns associated with emission reduction or sequestration activities. Specifically, the CPAC recommends exploring the development of a carbon content standard, which would function much like a cap and trade system although could potentially be implemented at a smaller geographic scale.

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[84] Specifically, the West Coast Governor's Initiative.

[85] A Cap and Trade program would set a mandatory cap on aggregate carbon emissions for a particular geographic area and provide individual carbon emitters with economic incentives to reach that cap at the lowest possible cost. Cap and Trade programs have been used to limit several pollutants in recent years, including sulfur dioxide.

Despite the intricacies of design details, the CPAC believes that these market-based instruments are a highly effective and important means of reducing GHG emissions, as well as providing other air quality benefits. The CPAC also believes that global competition will begin to dictate the use of market-based tools such as emissions trading to send market signals regarding the likely future liabilities of GHG emissions. The Puget Sound region needs to be well-positioned to participate effectively in national and international programs.

Preliminary modeling suggests that a regional Cap and Trade system[86] could provide significant reductions in electric sector GHG emissions, largely by providing the incentive to choose renewable power supplies instead of fossil-based power supplies in the future. While an emissions trading system might also support greater investments in renewable energy and efficiency, many of the gains in these areas can be achieved more reliably and effectively through the types of strategies described in Chapter Five above. The modeling analyses conducted for the Electricity Supply TWG looked at a modest Cap and Trade system, with CO_2 permit prices at around \$10/tCO_2. They found that, implemented in conjunction with efficiency and renewable energy strategies, the Cap and Trade system yields about 0.8 MMtCO_2e in emissions savings by 2020 (13% of remaining electric sector emissions) at an average cost of \$5 per metric ton of CO_2e reduced.[87]

While the analyses focused on the electricity supply sector, the CPAC recognizes that a Cap and Trade system does not need to be limited to utilities alone, and suggests that the development of a Cap and Trade system consider the important role of participants beyond the utility sector. In addition, the CPAC recognizes that a fully developed Cap and Trade program need not be in place for entities to participate in emissions trading and encourages voluntary GHG reductions through such trading.

[86] Including all Western States.
[87] As noted, the projected emission reductions were based on a permit price of \$10/tonCO2 and assume other efficiency and energy strategies are implemented.

10. EDUCATION

PRIORITY RECOMMENDATION

› **Promote Public Education and Citizen/Corporate/Government Action.**

BACKGROUND

At the heart of every strategy described above or needed to reduce GHG emissions across Puget Sound is the need to educate the region—governmental decisionmakers, developers, foresters, utility operators, homeowners, automobile drivers, all citizens—about the global climate challenge we now face and the choices we can make to minimize GHG emissions. Important information to impart includes: the sources and causes of GHGs; the potential environmental, economic and social impacts (or costs) associated with global warming; and strategies or actions to take to reduce GHGs. The CPAC believes that building awareness of the problems, solutions, and roles of various parties to address the region's climate change challenges will dramatically improve and enhance the region's ability to quickly meet its GHG emission reduction challenges.

PROMOTE PUBLIC EDUCATION AND CITIZEN/CORPORATE/GOVERNMENT ACTION

Key Action Item:

1. Develop a regional, and broader, two-part education approach focusing on:
   a. broad-based education and outreach campaign; and
   b. key messages and lessons for specific audiences.

The CPAC supports developing a two-part education strategy. The first part of the education strategy is a broad-based education and outreach campaign; the second part tailors key messages and lessons for specific audiences. The CPAC recommends building the broad-based campaign around outreach efforts designed to educate citizens about the potential impacts of global climate change on everyday lives, the benefits of climate solutions, and steps citizens can take to live GHG-friendly lives. This campaign should focus on solutions to climate issues and how implementing solutions will support the region in building a stronger economy. Possible actions to highlight include using transit (instead of single-occupancy vehicles), purchasing energy efficient appliances, or managing neighborhood trees to maximize their carbon sequestration and heating/shading value.

The second part of the education strategy should target changes in the behaviors of key audiences (e.g., local government officials and planners, utility operators, developers, architects, foresters, farmers, park managers, and/or small business owners). Important messages should highlight the economic as well as environmental benefits of changing behavior. Citizens who wish to take a more active role in reducing their own personal GHG impact on the atmosphere may likewise be a target audience for more focused outreach.

The CPAC suggests that any education or outreach effort follow a basic four-step approach to implementation:

Step 1. Develop high-level and targeted messages related to issues of interest (e.g., energy efficient building design or forest management to encourage greater carbon sequestration).

Step 2. Coordinate outreach with other efforts (i.e., integrate global climate change messages into other messages, including those related to environmental protection, energy efficiency, and economic development).

Step 3. Build partnerships with other organizations to promote key messages. As the imperative for acting to curb GHGs grows, so too will the network of organizations—governmental, non-profit, business—focused on limiting global climate change.

Step 4. Target education and training for specific audiences. The CPAC has targeted the following key audiences for early targeted education and outreach efforts:

- ➔ Developers and contractors—for information about energy efficiency design and construction (cement substitution, use of wood building materials) as well as energy code requirements;
- ➔ Building operators—regarding equipment maintenance and energy efficient devices;
- ➔ Retailers—about energy efficient appliances;
- ➔ Employers—regarding options to reduce VMT, such as flex-time and commuter-trip-reduction plans;
- ➔ Technology industry—to highlight potential economic opportunities associated with addressing climate change;
- ➔ Foresters—about strategies to maximize carbon sequestration in stands of timber;
- ➔ Consumers—about home heating fuel choices/fuel conversion options and green power options;
- ➔ Homeowners—about ways to and benefits of protecting and preserving residential trees and larger timber lots to maximize carbon sequestration and increase the value of standing timber;

- ➔ Automobile owners—regarding vehicle choices, maintenance and operation, as well as transportation alternatives;
- ➔ Local governments—about ways to update planning, zoning, or construction codes to encourage GHG-friendly options and about incentives to encourage developers and others to pursue these options;
- ➔ Air travelers—regarding opportunities to mitigate individual CO_2 emissions resulting from air travel; and,
- ➔ Sectors that will be most acutely affected by climate disruption, such as water resource agencies, irrigation districts, municipal water suppliers, ski areas, etc.

11. LOCAL GOVERNMENT

PRIORITY RECOMMENDATION

› **Encourage local government to act.**

BACKGROUND

As the region's emissions inventory illustrates, the actions of individuals, businesses, industry and government all contribute to the region's emissions; thus, it follows that all share in the responsibility to contribute to GHG reductions.

Local governments are especially well positioned to take actions to reduce greenhouse gas emissions. In fact, local governments have been in the vanguard in climate protection activities locally and nationally; for example, here in the Puget Sound region, both King County and the City of Seattle, among others, are well recognized for their leadership and successes. As major landowners, employers, building mangers, fleet operators, utility owners and consumers of goods and services, local governments have both the opportunity and the capacity to bring about significant improvements in avoiding and reducing greenhouse gas emissions.

Many local governments have chosen to act because they recognize they are on the front line in planning for and managing the potential impacts of climate change – such as the increased potential for flooding, changes in the hydrological cycle that may impact water supply and demand, etc. But there are many other reasons local government leadership is important:

- ➔ The benefits of climate protection actions taken by local government accrue locally and have a positive impact on the local quality of life. For example, more energy efficient homes means that the people who live in the region spend less for heating and cooling. Reduced traffic congestion contributes to healthier air and faster commute times – important to a positive quality of life.
- ➔ Local government support for new clean energy technologies provides new job opportunities in the region, building the economy,

As taxpayer funded entities, local governments have an obligation to use natural resources efficiently and wisely; by incorporating energy efficiency and waste reduction into their own operations, they are reducing the cost of government and saving taxpayer dollars.

There are many actions that local government can and should take to contribute to reducing GHG emissions – and many of these actions are equally applicable to any large operation including state government, educational institutions and businesses. Other actions, however, are more unique to local government.

ENCOURAGE LOCAL GOVERNMENT TO ACT

Key Action Items:

1. Lead by example.
2. Create partnerships and leverage existing opportunities
3. Advocate for GHG emission reduction actions.
4. Provide technical assistance, funding, incentives and regulation.

The CPAC recommends that the Puget Sound Clean Air Agency Board and the jurisdictions within the Agency's four-county region engage on the recommendations within this report and move forward on GHG reduction actions. In particular, as the Clean Air Agency determines how to engage in this issue statewide, regionally, nationally and beyond, as we recommended on page 14 of this document, we urge the Clean Air Agency, to consider the following roles or actions to provide critical leadership:

- ➔ Advocate and engage with the state and the federal government for action on these recommendations which promote solutions at a scale larger than the central Puget Sound.
- ➔ Support the local governments in the Clean Air Agency jurisdiction as they develop the knowledge and tools needed to reduce GHG emissions.
- ➔ Build partnerships with local governments, business, communities and others to better understand the opportunities and barriers that we face as we move forward.
- ➔ Establish the policy framework needed to set goals, establish timelines and assess progress on the road to climate stabilization.
- ➔ Educate all citizens of the region regarding the causes of global warming and the potential feasible actions and decisions people and businesses can take to make a contribution to the solution.

Regarding local government in general, the CPAC recommends the following paths for action and has included specific action examples:

1. Leading by example

Opportunities to reduce greenhouse gas emissions and lead by example abound; the actions listed below are equally applicable to all large operations and, once employees are aware of them in the workplace, may be more inclined to practice similar actions at home. Many of the measures will also produce cost savings. Specific actions include:

- ➔ Reduce fleet emissions through more fuel efficient vehicles, employee education, use of alternatives such as electric bicycles and Segways for campus type applications, use of biodiesel, etc.
- ➔ Provide commute trip incentives for employees to discourage use of single occupancy vehicles such as subsidies for transit passes, assigning employees to work sites that allow the most efficient commute, not offering free parking, etc.
- ➔ Promote and practice building energy efficiency in constructing and operating buildings. For example, LEED Silver certification for new buildings and Energy Star Portfolio Manager for existing buildings. Purchase only Energy Star compliant appliances and electronics. Work with the local electric utility to request technical and financial assistance for energy conservation measures.
- ➔ Sign up for green power where utilities offer it.
- ➔ Work with employees and building maintenance staff to increase recycling rates.
- ➔ Educate the workforce about climate change; set targets for energy conservation, waste reduction, reduced VMTs, etc.

2. Creating partnerships and leveraging existing opportunities

Government partnerships with other entities can leverage and strengthen GHG reduction efforts and make them more effective; many of these already exist. For example:

- ➔ Partnerships with trade associations, commercial building owner and operator groups and companies and others to promote energy efficient goods and services.
- ➔ Partner with utilities to help promote their energy conservation programs.
- ➔ Leverage communication tools/platforms (e.g., city/county television stations, transit vehicles, buses, trains, vanpools,) for educating on climate change, commuter choices, energy efficiency, green power etc.
- ➔ Collaborate with universities, other jurisdictions to develop a standard format for inventorying air emissions data
- ➔ Partner with school districts to educate students on transportation choices and options
- ➔ Support existing and/or develop appliance retirement programs that target older inefficient appliances. A program should consider economic and environmental costs of replacement/retirement of such appliances.
- ➔ Partner with public and private sector entities to study the economic consequences to the region resulting from climate change impacts.

3. Advocating for GHG emission reduction actions

Encourage/support and engage in activities that will reduce GHG emissions.

- Through local, state and national political processes and associations, advocate for climate protection leadership and action. Examples include: encouraging BPA to integrate the recommendations from the Power Council's Fifth Power Plan into BPA contracts with utilities and advocating for negotiated agreements with public and private entities to take actions that will reduce GHG emissions

4. Providing technical assistance, funding, incentives and regulation

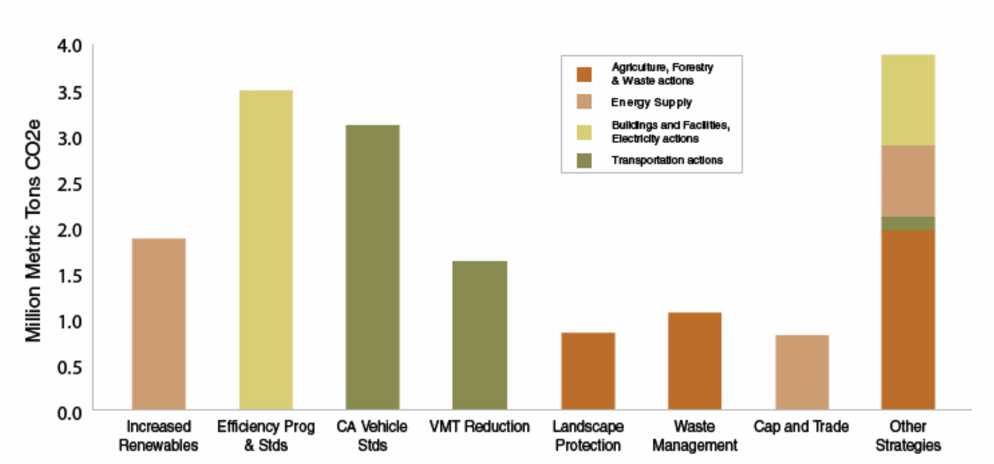
Support the efforts of others engaged in GHG reduction activities through technical assistance and/or funding, Develop regulations to facilitate the reduction of GHGs.

- Private and municipal utilities should provide energy efficiency technical assistance to customers and provide incentives for cost effective conservation measures.
- Incorporate climate change considerations into comprehensive planning, e.g., development incentives for retaining trees, increasing housing density, convenient access to transit, etc
- Ensure good enforcement of energy codes, e.g., building code staff are fully trained
- Develop and provide incentives to advance the reduction of GHG's in construction and development. Establish "baseline" emission standards against which improved construction and land use practices could be measured and incentive programs could be implemented.

CONCLUSION

The recommended actions above represent an important and significant first step. While they provide meaningful reductions (see Figure H below), the CPAC believes they represent a small portion of the total actions needed to address climate change on a long-term basis. The region must set explicit goals for GHG emission reductions and continue on a path to achieve those broader climate change goals.

Figure H: Emission Savings from Key Action Items, 2020



The recommended actions also present an opportunity to deliver significant economic benefits to the regional economy through a variety of savings and technology development, to avoid what will be significant costs resulting from climate change, to contribute to global efforts to curb and reverse climate change patterns, and, finally to preserve the quality of life as we know it in the Puget Sound region.

To seize upon these opportunities will take commitment from all of us—individuals, businesses, and governments. It will require changes in our behavior and in many instances, upfront investments that will not result in immediate or short-term returns. The option of doing nothing however, represents greater costs without any possibility of a positive return.

At its foundation, this report is a call to action. The Puget Sound region must work strenuously and deliberately to change the course of its ever increasing GHG emissions. Much work needs to be done to implement the recommended actions. There is much to gain if we act now, and much to lose if we do not. We urge the Clean Air Agency, and all readers of this report, to determine what they can do to move our recommendations forward and explore how to go beyond them, as well.

APPENDIX A – CPAC Members

NAME	ORGANIZATION
Rod Brandon	King County EO/PSDM – Policy & Strategy
Karin Bulova	Snohomish County PUD
John Cabaniss	Association of International Automobile Manufacturers
Eli Cooper/Kelly McGourty	Puget Sound Region Council
Kim Drury	City of Seattle
Gene Duvernoy	Cascade Land Conservancy
Jake Fey, Co-chair	WSU Coop-Extension Energy Program
Diana Gale	Cascade Center for Public Service
Stephen Gerritson	Commuter Challenge
David Goldberg, AIA	Mithun Architects + Designers + Planners
KC Golden	Climate Solutions
Wayne Grotheer, Co-chair	Port of Seattle
Frank Holmes	Western States Petroleum Association
Ken Johnson	Weyerhaeuser Company
Carol Jolly	Washington State Governor's Office
Bill Kidd	BP Oil Company
Chuck Kleeberg	Pierce County Planning and Land Services
Bill LaBorde	NW Energy Coalition
Dave Moore	The Boeing Company
Robert Pregulman	Washington PIRG
Stan Price	NW Energy Efficiency Council
Roby Roberts	PPM Energy, Inc.
Steve Secrist	Puget Sound Energy
Gary Smith	Independent Business Association
Lucy Steers	League of Women Voters, Growth Management Chair

APPENDIX B – Technical Working Group Members

NAME	ORGANIZATION
AGRICULTURE, FORESTRY, SOLID WASTE TWG	
Pieter Bohen	Cascade Land Conservancy
Stu Clark	Washington State Department of Ecology
Jeff Compton	The Nature Conservancy
Kimberly Freeman	Pierce County Planning and Land Services
Diana Gale	Cascade Center for Public Service
Steve Gerritson	Sierra Club
Tony Ifie	Washington State Department of Natural Resources
Ken Johnson	Weyerhaeuser Company
Donald McKenzie	USDA Forest Service
Eric Nelson	King County Department of Natural Resources
Gordon Smith	Ecofor
BUILDINGS AND FACILITIES TWG	
Karin Bulova	Snohomish County PUD
Rod Brandon	King County EO/PSDM
Jake Fey	WSU Coop-Extension Energy Program
David Goldberg	Mithun Architects + Designers + Planners
Roel Hammerschlag	Institute for Lifecycle Energy Analysis
Jeff Harris	NW Energy Efficiency Alliance
Frank Holmes	Western States Petroleum Association
Chuck Kleeberg	Pierce County Planning and Land Services
Dave Moore	The Boeing Company
Rob Pregulman	Washington PIRG
Stan Price	NW Energy Efficiency Council
Steve Secrist	Puget Sound Energy
Gary Smith	Independent Business Association
Mary Smith	Puget Sound Energy
ENERGY SUPPLY TWG	
Lynn Best	Seattle City Light
Karin Bulova	Snohomish County PUD
Tom Eckman	NW Power and Conservation Council
Jake Fey	WSU Coop-Extension
KC Golden	Climate Solutions
Doug Howell	King County DNR
Bill LaBorde	NW Energy Coalition
Robert Pregulman	Washington PIRG
Roby Roberts	PPM Energy, Inc.
Chris Robinson	Tacoma Power
Mike Ruby	Envirometrics, Inc.
Steve Secrist	Puget Sound Energy
Tony Usibelli (Mark Anderson)	WA State Dept. Community, Trade & Economic Dev

TRANSPORTATION TWG	
John Cabaniss	Association of International Automobile Manufacturers
Dan Clarkson	Prometheus Energy Company
Eli Cooper/Kelly McGourty	Puget Sound Regional Council
Maggie Corbin	Clean Cities Coalition
Kim Drury	City of Seattle
Steve Gerritson	Sierra Club
Wayne Grotheer	Port of Seattle
Frank Holmes	Western States Petroleum Association
Doug Howell	King County DNR
Peter Hurley	Transportation Choices Coalition
Bill Kidd	BP Oil Company
Bill LaBorde	NW Energy Coalition
Lucy Steers	League of Women Voters, Growth Management Chair
Mia Waters	Washington State Dept of Transportation

APPENDIX C – Additional Process Information

CPAC

The CPAC met six times between January 2004-December 2004. The Clean Air Agency lead staff and technical consultants provided the CPAC with a comprehensive list of potential GHG reduction strategies. This list includes strategies that are either currently used or being considered by other governments interested in reducing GHGs. The CPAC used this list as a starting point to identify strategies that might hold potential for our region and our state. (See Appendix D for this full list of strategies.)

Technical Working Groups

The TWGs included CPAC members as well as other technical experts such as academics and consultants. A complete list of TWG members is included in Appendix A. Each TWG was supported by independent technical and process consultants.[1]

The TWGs each met between six and eight times over the course of the CPAC process. They reviewed the emissions inventories for their respective sectors, and culled the comprehensive strategy list. They prepared a short-list of strategies for the CPAC referred to as "high interest strategies." They presented this list to the CPAC and then directed the technical consultants to prepare detailed cost/benefit analyses and GHG reduction estimates on each of these high interest strategies. At the CPAC's direction, the TWGs also recommended (but did not analyze) as short list of additional GHG reduction strategies referred to as Deserves Further Consideration. These strategies are listed in Appendix M

[1] The ES and BF TWGs were supported primarily by Michael Lazarus and Alison Bailie of the Tellus Institute; the Transportation TWG was supported by Greg Dierkers of the Center for Clean Air Policy; and the AFSW TWG was supported by Tom Peterson, an Associate Professor at Pennsylvania State University. Facilitation support for the TWGs and the CPAC was provided by Bill Ross, Megan Duffy, Sarah Calvillo, and Anne Dettelbach of Ross & Associates Consulting, Ltd.

APPENDIX D - Preliminary List of GHG Reduction Opportunities

	Electricity Supply GHG Reduction Opportunities
1.0	**Renewable Energy Strategies**
1.1	Renewable Portfolio Standards
1.2	Public Benefit Charge Funds
1.3	Tax Credits and Incentives
1.4	Green Power Purchases and Marketing
1.5	Support for Wind development (zoning, siting, etc.)
1.6	Advanced Biomass Technology support (e.g. Gasification)
1.7	Biomass Co-firing at Coal Plants (also in Ag, Forestry, Waste)
1.8	Research and Development (R&D)
1.9	Landfill Gas Recovery (see also Waste)
1.10	Waste to Energy (see also Waste)
2.0	**Advanced Fossil Fuel Strategies**
2.1	Carbon Capture and Sequestration (CCS)
2.2	Combined H2/electricity production from fossil fuels with sequestration
2.3	Advanced fossil technologies (e.g. IGCC)
2.4	Fuel Cell Development Incentives
2.5	Tax Credits and Incentives
2.6	Research and Development (R&D)
3.0	**Other Electricity Measures**
3.1	Efficiency Improvements and Repowering Existing Plants
3.2	Nuclear Plant Relicensing and Uprating
4.0	**Distributed Generation (DG)**
4.1	Combined Heat and Power Incentive Policies and Barrier Reduction
5.0	**Emissions Policies**
5.1	Utility sector GHG Cap and Trade
5.2	Generation Performance Standards
5.3	GHG Offset/mitigation requirements for new power plants
5.4	GHG Offset/mitigation requirements for existing power plants
5.5	Voluntary Utility CO2 Targets and/or Trading
5.6	CO2 Tax
6.0	**Grid and Utility Policies**
6.1	Interconnection Rules for clean, distributed generation
6.2	Remove Transmission Barriers for Renewable and other Clean DG
6.3	Net Metering
6.4	Pricing and metering strategies
6.4.1	Remove Utility Rate Barriers
6.4.2	Advanced Metering
6.4.3	Time-of-use Rates
6.5	Load Management (no clear GHG savings)
6.6	Transmission System Upgrading
6.7	Reduce Transmission and Distribution Line Loss
7.0	**Education/Awareness**
7.1	Brownfield Re-development
7.2	Environmental (emissions) Disclosure
7.3	Public Education

Other Energy Supply GHG Reduction Opportunities	
1	**Natural Gas System**
1.1	Leakage reduction program
2	**Hydrogen**
2.1	Incentives for hydrogen development

Comprehensive Programs for GHG Reduction in Residential, Commercial and Industrial Sectors	
1	Mandatory Reporting of Fuel Use, GHG Emissions
1b	*Voluntary Reporting of Fuel Use, GHG Emissions (i.e. Registry)*
2	State-wide Energy Efficiency/GHG Emission Reduction Goals
3	Government Agency Requirements and Goals
4	Efficiency requirements (e.g. Energy Portfolio Standards)
5	Public Benefit Funds
6	Negotiated Agreements
7	Procurement of EE equipment
8	Small-source aggregation

Residential Sector GHG Reduction Opportunities	
1	**Improve EE of Appliances**
1.1	Energy Efficiency Appliance Standards
1.2	Discounts/Rebates/Tax Incentives for Energy Star Products
1.3	Contractor Education: Proper sizing of HVAC
1.4	Consumer Education: Selection, Alternate appliance choices
1.5	Bulk Purchasing Program
1.6	Incentives to Technology Providers
1.7	Appliance Recycling/Pick-Up Programs
2	**Improve EE and SD of Buildings**
2.1	Improved Building Codes
2.2	Training and Enforcement of Building Codes
2.3	EPA Energy Star Homes
2.4	"Green" Standards for New Construction/ Renovations (e.g. LEED)
2.5	Energy Efficiency Mortgages
2.6	White Roofs and Rooftop Gardens
2.7	Landscaping
2.8	Education to homeowners
3	**Improve Energy Management**
3.1	Weatherization
3.2	Training of Building Operators
3.3	Efficient Use of Oil and Gas
3.3.1	Building envelope
3.3.2	Heating
3.3.3	DHW
3.3.4	Cooking
3.4	Efficient Use of Electricity
3.5	Educate residents/ public/ children
3.5.1	Marketing Programs

3.5.2	Introduce in School Curriculum
4	**Other**
4.1	Incentives for Renewable Energy Applications
4.2	Fuel Switching to less carbon-intensive fuels
	See also “Comprehensive Programs”

	Commercial Sector GHG Reduction Opportunities
1	**Improve EE of Equipment and Appliances**
1.1	EE Equipment and Appliance Standards
1.2	Tax Incentives for EE Equipment and Appliances
1.3	Discounts on Energy Star Products
1.4	Bulk Purchasing Program
2	**EE Buildings**
2.1	Improved Building Codes
2.2	Training and Enforcement of Building Codes
2.3	"Green" Standards for New Construction/ Renovations
2.4	Energy Tracking and Benchmarking
2.5	Incentive payment for green buildings
2.6	White Roofs and Rooftop Gardens
	Increased use of cement substitutes (pozzolans)
2.7	State-wide EE Goals and Reporting for Government Buildings
3	**Energy Management**
3.1	Building Recommisioning
3.2	Training of Building Operators
3.3	Efficient Use of Oil and Gas
3.3.1	Building envelope
3.3.2	Heating
3.3.3	DHW
3.3.4	Other
3.4	Efficient Use of Electricity
3.4.1	Lighting
3.4.2	A/C
3.4.3	Ventilation
3.4.4	Pumps/motors
3.4.5	Other
3.5	Shared Savings Program for Government Agencies
3.6	Load Management
4	**Other**
4.1	Net-metering
4.2	Time of Use Rates
4.3	Encourage Green Power Purchases
4.4	Encourage Clean Combined Heat and Power
4.5	Incentives for Renewable Energy Applications
4.6	Fuel Switching to less carbon-intensive fuels
	See also "Comprehensive Programs"

	Industrial Sector GHG Reduction Opportunities
1	**Industrial EE, Management, and Conservation**
1.1	Efficient Use of Oil and Gas

1.1.1	Boilers
1.1.2	Upgrade to steam system
1.1.3	Process-specific equipment
1.1.4	Building Envelope
1.1.5	Other
1.2	Efficient Use of Electricity
1.2.1	Pumps
1.2.2	Motors
1.2.3	Lighting
1.2.4	Cooling
1.2.5	Optimization of Compressed air systems
1.3	Curtailment programs
1.4	Energy Management Training
1.5	R&D of new technologies
1.6	Financial incentives for Improvements
1.7	EE education for SMEs
1.8	Increased use of cement substitutes in cement industry
2	**Reduction in Process Gases**
2.1	Participate in Voluntary Industry-Government Partnerships
2.2	Leak Reduction Programs
2.3	Process Changes/ Optimization
2.4	Capture, Recovery and Recycling of Process Gases
2.5	New Equipment
2.6	Substitution of High GWP Gases
3	**Supply Side Measures**
3.1	Net-metering
3.2	Encourage Green Power Purchases
3.3	Encourage Clean Combined Heat and Power Generation
3.4	Incentives for Renewable Energy Applications
4	**Other programs**
4.1	Industrial ecology/ by-product synergy
4.2	Negotiated Agreements
4.3	Cap and Trade
	See also “Comprehensive Programs”

	Transportation and Land Use Sector GHG Reduction Opportunities
1.0	**Passenger Vehicle GHG Emission Rates**
1.1	***Vehicle Technology***
1.1.1	Tailpipe GHG Emission Standards
1.1.2	ZEV/LEV-2 Implementation
1.1.3	R&D on Low-GHG Vehicle Technology (e.g., fuel cell)
1.1.4	Add-on Technologies (Low Friction Oil, Low-Rolling Resistance Tires)
1.2	***Vehicle Operation***
1.2.1	Enforce Speed Limits
1.2.2	Vehicle Maintenance, Driver Training
1.2.3	Transportation System Management
1.3	***Incentives & Disincentives***
1.3.1	Procurement of Efficient Fleet Vehicles
1.3.2	Feebates (state-specific or regional)
1.3.3	CO_2-based registration fees
1.3.4	Tax Credits for Efficient Vehicles
1.3.5	Vehicle Scrappage
2.0	**Slowing VMT Growth**
2.1	Develop packages to slow VMT growth/reduce VMT
2.2	***Land Use and Location Efficiency***
2.2.1	Increase Infrastructure Funding for Efficient Locations
2.2.2	-- Infill, Brownfield Re-development
2.2.3	-- Transit-Oriented Development
2.2.4	Smart Growth Planning, Modeling, Tools
2.2.5	Targeted Open Space Protection
2.3	***Increasing Low-GHG Travel Options***
2.3.1	Increase Transportation Funding for Efficient Modes
2.3.2	-- Improve Transit Service (frequency, convenience, quality)
2.3.3	-- Transit Marketing and Promotion
2.3.4	-- Bike and Pedestrian Infrastructure
2.3.5	-- Expand Transit Infrastructure (rail, bus, BRT)
2.3.6	-- HOV lanes
2.3.7	Fix-it-First
2.3.8	Identify Other Revenue Sources (General Fund)
2.3.9	Transit Prioritization (signal prioritization, HOV lanes)
2.3.10	Telecommute and Live-Near-Your-Work
2.3.11	Car sharing
2.3.12	E-Commerce
2.4	***Incentives & Disincentives***
2.4.1	Commuter Choice/Parking Cash Out
2.4.2	VMT Tax
2.4.3	Pay As You Drive Insurance
2.4.4	Increased Fuel Tax (w/ targeted use of revenue towards travel alternatives)
2.4.5	Location-Efficient Mortgages
2.4.6	Congestion Pricing (or tolls) (w/ targeted use of revenue towards travel alternatives)

2.4.7	Parking Pricing or Supply Restrictions
2.4.8	Transit Repositioning
2.4.9	Transit Pricing Incentives
2.4.10	VMT/GHG Offset Requirements for Large Developments
2.4.11	Benefits for Low GHG Vehicles (preferential parking, use of HOV lanes)
3.0	**Fuel Measures**
3.1	Low-GHG Fuel Standard (e.g., renewable)
3.2	Pump tax to fund H_2 infrastructure
3.3	Low-GHG Fuel for State Fleets (e.g., biodiesel)
3.4	Alternative Fuel Infrastructure Development (e.g. hydrogen)
4.0	**Freight**
4.1	***Vehicle Technology***
4.1.1	Vehicle Technology Improvements (e.g., aerodynamics)
4.1.2	R&D on Low-GHG Vehicle Technology
4.1.3	Low-sulfur diesel (use of particulate traps, other complementary technologies)
4.2	***Vehicle Operation***
4.2.1	Freight Logistics Improvements/GIS
4.2.2	Enforce Speed Limits
4.2.3	Improve Traffic Flow
4.2.4	Increased Size & Weight of Trucks
4.2.5	Increase the Number of Rest Areas
4.2.6	Pre-clearance at Scale Houses
4.2.7	Truck Stop Electrification
4.2.8	Enforce Anti-Idling
4.3	***Increasing Low-GHG Travel Options***
4.3.1	Intermodal Freight Initiatives
4.3.2	Raise Commuter Rail Wires
4.3.3	Feeder Barge Container Service
4.4	***Incentives & Disincentives***
4.4.1	Procurement of Efficient Fleet Vehicles (public, private or other)
4.4.2	Incentives to Retire or Improve Older Less Efficient Vehicles
4.4.3	Maintenance and Driver Training
4.4.4	Increased Truck Tolls or Highway User Fees
5.0	**Intercity Travel: Aviation, High Speed Rail, Bus**
5.1	High-speed Rail
5.2	Integrated Aviation, Rail, Bus Networks
5.3	Aircraft emissions
5.4	Airport Ground Equipment
6.0	**Off-Road Vehicles (construction equipment, out-board motors, ATVs, etc)**
6.1	Incentives for Purchase of Efficient Vehicles/Equipment
6.2	Improved Operations, Operator Training
6.3	Maintenance Improvements
6.4	Increased Use of Alternative Fuels or Low Sulfur Diesel
7.0	**Cross Cutting Issues**
7.1	Education (e.g. Trip Chaining)
7.2	Interaction with SIPs (e.g. co-benefits, synergies etc)
7.3	GHG Registry & Emissions Trading

Agriculture GHG Reduction or Removal Opportunities	
1	Production of Fuels and Electricity
1.1	Ethanol production
1.2	Biodiesel production
1.3	Manure Digesters (linked with manure management below)
1.4	Ag Biomass Feedstocks for Electricity
2	Fertilizer and Manure Management
2.1	Nutrient Management (improve efficiency of fertilizer use)
2.1.1	Reduce non-farm fertilizer use
2.2	Manure Management
2.2.1	Composting
2.2.2	Change feedstocks
3	Soil Carbon Management
3.1	Conservation tillage/No-till (sequestration and reduced energy use)
3.2	Reduce summer fallow
3.3	Increase winter cover crops
3.4	Improve water & nutrient use
3.5	Rotational grazing/Improve grazing crops
4	Land use change
4.1	Convert land to grassland or forests
4.2	Preserve open space/agricultural land
4.2.1	Promote "no net loss" of agricultural land
5	Farming Practices
5.1	Convert farm equipment from diesel to LNG (or hybrids)
5.2	Organic Farming
5.3	Support Local Farming/Buy Local

Forestry GHG Reduction or Removal Opportunities	
1	Forest carbon sequestration
1.1	Afforestation and Reforestation
1.2	Modified Forest Management Practices
1.2.1	Longer rotation forestry
1.2.2.	Changes to Forest Practices Guidelines or their enforcement
1.3	Urban Forestry
1.4	Forest preservation
1.5	Promote Use of Wood Products
1.5.1	State procurement of locally grown wood products
2	Forestry: Energy Production
2.1	Forest products biomass feedstocks for electricity
2.2	Improve efficiency of wood burning stoves

Waste Management GHG Reduction Opportunities	
1	Waste Management Strategies
1.1	Advanced Recycling and Composting
1.2	Source Reduction Strategies
1.2.1	Resource Management Contracting
2	Landfill Gas Strategies
2.1	Flare Landfill Methane at non-NSPS (smaller) sites
2.2	Convert Landfill Methane to Energy
3	Wastewater Activities
3.1	Energy Efficiency Improvements
3.2	Lower Waste Processing Needs (lower water consumption, waste production)
3.3	Methane and Biogas Energy Programs
3.3.1	Install digesters and turbines
3.3.2	Install fuel cells

APPENDIX E – Technical Working Group - Initial Strategy Lists

Building and Facilities GHG Reduction Opportunities

Cross-Cutting B&F (across Residential, Commercial and Industrial)
1. **Efficiency Portfolio Standards** would require utilities to meet a certain fraction of their retail loads through (cost-effective) conservation and related investments.
2. **Public Benefit Charge (PBC) Funds** are collected as surcharge on utility bills, as a means to support energy efficiency, renewable energy, and low-income programs. They are currently in place in about 15 states, including OR and CA.
3. **Appliance Efficiency Standards** can be implemented at the state level for a number of appliances, and are among the strategies included in the West Coast Governors' agreement.
4. **Tax Incentives, Discounts or Rebates for Efficient Equipment and Appliances** would promote adoption of Energy Star, CEE Tier 2, or otherwise rated devices.
5. **HFC Reduction Opportunities** should be explored, given this rapidly growing emissions source. Most HFC emissions result from air conditioning and refrigeration applications.
6. **Building Code** measures could emcompass: a) training of building officials; b) improved code enforcement; and/or c) changes to the code (e.g. for lighting, windows, and duct efficiency) Public utility hook-up standards provide an alternative, but less desirable implementation strategy.
7. **Incentives for Renewable Energy Applications,** such solar photovoltaic systems, solar water heaters, and other buildings and facility applications may be reconsidered later
8. **Encourage Green Power Purchases,** at various levels. May be folded into a broader education strategy. Will consider in the future the appropriate level of analysis.
Residential Sector
9. **Efficiency and Fuel Switching Opportunities for various end-uses, in new and existing buildings.** This option comprises the wide array of options available spanning lighting, weatherization, heating/cooling systems upgrade and fuel switching, duct sealing, and water heating upgrade and fuel switching, and other equipment. Potentials can be evaluated in light of existing studies and conservation activities, and may be achieved through cross-cutting options (above) or other implementation strategies yet to be specified.
10. **Incentives for Low-GHG design (new construction),** such as Energy Star Homes and the Master Builders BuiltGreen, as well as **lower square footage.**
11. **Education of residents/ public/ children** could be considered alongside other education activities.
12. **Appliance retirement programs,** which typically target older refrigerators and freezers of limited usage, are being pursued by some local utilities. They will be tracked but are unlikely to yield long-term emissions savings.
13. **Bulk Purchasing Programs for Housing Developments** would acquire higher efficiency appliances. Might be included in an overall education strategy.
14. **Consumer/Merchant Education**: Appliance choices and sizing. Considered part of the cross-cutting incentives option.
15. **Incentives to Technology Providers**

16. **Standards for Construction/Renovations** (e.g. LEED). Integrated under low-GHG design option.
17. **Energy Efficiency Mortgages**. Considered to have limited impact.
18. **White Roofs and Rooftop Gardens**. Integrated under low-GHG design option.
19. **Landscaping.** Integrated under low-GHG design option.
20. **Education to homeowners**. Implicit in other measures
21. **Weatherization/building envelope.** Included in integrated strategy above
22. **CFL Lighting.** Included in integrated strategy above.
23. **Duct Sealing:** Contractor Education, Incentives, etc. Included in integrated strategy above.
24. **Controls.** Included in integrated strategy above.
25. **Water Heater: Retrofit/Upgrade.** Included in integrated strategy above.
26. **Water Heater Fuel Switching.** Included in integrated strategy above.
27. **Other Equipment** (Cooking, Refrigeration, Dishwasher, Clothes Washers, etc.). Included in integrated strategy above.
Commercial Sector
28. **Efficiency and Fuel Switching Opportunities for various end-uses, in new and existing buildings.** This option comprises the wide array of commercial sector options available -- across lighting, HVAC systems, refrigeration, fuel switching, networked PC management, power supplies, and other equipment. A parallel to the residential sector option above.
29. **Incentives for Low GHG Design (Best Practices – new construction)** as above for residential (including Energy Tracking and Benchmarking, Incentive payments, LEED standards, low GHG building materials)
30. **Building Recommissioning,** a management tool for identifying system operating, control, and maintenance problems in existing buildings.
31. **Training of Building Operators** provides another tool to reduce fuel and electricity use in existing buildings.
32. **Water and Wastewater Treatment** efficiency improvements involve process controls and pumps to reduce energy use and can be implemented by government agencies
33. **Government Efficiency Goals & Reporting for New Buildings** are supported for their demonstration and education potential.
34. **Building Commissioning,** a process to ensure that new construction achieves its full design characteristics, will be reconsidered if not adequately covered through building code, code enforcement, and other measures.
35. **Discounts on Energy Star Products**. Considered part of the cross-cutting incentives option.
36. **Energy Tracking and Benchmarking.** Integrated under low-GHG design option.
37. **Incentive payment for green buildings**. Integrated under low-GHG design option.
38. **White Roofs and Rooftop Gardens**. Integrated under low-GHG design option.
39. **Daylighting**. Integrated under low-GHG design option.
40. **Building Materials**: Use of cement substitutes, substitution of wood products for cement/steel. Integrated under low-GHG design option.
41. **Networked PC Management.** Included in integrated strategy above.
42. **Power Supplies.** Included in integrated strategy above.
43. **Weatherization/Building envelope.** Included in integrated strategy above.
44. **HVAC systems.** Included in integrated strategy above.
45. **Hot Water systems.** Included in integrated strategy above.

46. **Cooking/heat recovery/exhaust hoods.** Included in integrated strategy above.
47. **Lighting.** Included in integrated strategy above.
48. **Pumps/motors.** Included in integrated strategy above.
49. **Cooking/other** (heat recovery)/ exhaust hoods for labs. Included in integrated strategy above.
50. **Shared Savings Program for Government Agencies**. Considered too detailed an implementation strategy at this point.
51. **Load Management**. Considered by ES group.
52. **Net-metering**. Legislation already in place.
53. **Time of Use Rates**. Considered by ES group.
54. **Encourage Clean Combined Heat and Power**. Considered by ES group.
55. **Fuel Switching to less carbon-intensive fuels.** Included in integrated strategy above
Industrial Sector
56. **Retrofits, Upgrades, Optimization, and Fuel Switching (Boilers, steam system, pumps, motors, compressed air, etc.)** This "umbrella" category is similar to the residential and commercial ones. It spans the wide array of industrial sector options available, with various implementation options to be specified later.
57. **Opportunities in cement production,** to reduce energy use and process CO2 emissions (e.g. by substituting fly ash for cement)
58. **Energy Management Training and related activities** would aim to capture energy savings and emissions reductions from improved O&M of existing equipment. 59. **Research and Development of new technologies.**
60. **Energy efficiency education for small and medium enterprises.**
61. **Industrial ecology/ by-product synergy,** otherwise referred to as cleaner production systems was seen as desirable, but not central to the discussion of GHG strategies.
62. **Negotiated Agreements,** e.g. between emitters and regulatory agencies (as an alternative to penalties or future regulation) may be worth revisiting later.
63. **Cap and Trade** systems for industrial GHG emissions. The TWG recognized that the Energy Supply TWG is analyzing Cap and Trade in greater detail and agreed to track that group's discussions and recognize the link with the BF TWG.

Industrial Sector – Continued
64. **Curtailment programs.**
65. **Financial incentives for Improvements.** Implicit in other strategies.
66. **Reduction in Process Gases.** Process gas emissions (other than cement CO2 and HFCs) are very limited. This includes (from earlier list): • Voluntary Industry-Government Partnerships • Leak Reduction Programs • Process Changes/ Optimization • Capture, Recovery and Recycling of Process Gases • Substitution of High GWP Gases
67. **Net-metering.** Legislation already in place.
68. **Encourage Green Power Purchases.** See cross-cutting measure above.
69. **Encourage Clean Combined Heat and Power.**
70. **Incentives for Renewable Energy Applications.** See cross-cutting measure above.

FORESTRY, WASTE AND AGRICULTURE

MITIGATION OPTION
Forestry
1. **Manage rural forests for greater carbon savings** by thinning existing stocks and or altering harvest practices to reduce disturbance of carbon stocks in soils and the forest floor. These practices, which could include a number of variations depending on species and site characteristics, could: 1) maintain carbon sequestration rates that otherwise would decline, and 2) expand the use of biomass for wood products or energy as an alternative to materials and energy sources that emit more CO2. Biomass products and energy production could involve a number of specific mitigation programs. For energy production, these might include biomass electricity feed stocks for co-firing or gasification, or improved methods of direct biomass conversion.
2. **Expand the use of forest biomass for electricity feed stocks** to displace power generation from higher emissions sources (such as gas and coal) and to improve carbon sequestration and wood products flow in thinned stands. This strategy was moved to fit under the forest management strategy. (See above.)
3. **Support "no net loss" of existing forest lands to non forest land uses** to protect carbon storage and energy crop potential, and to reduce transportation emissions associated with development that is not location efficient
4. **Manage urban forests for greater carbon savings,** and potentially energy and CO2 savings associated with windbreaks, by encouraging retention and care of existing forests or trees. The TWG suggested perhaps combining this and the following strategy as part of a broader education strategy

5. **Increase tree planting in urban and suburban areas** to increase carbon sequestration rates**,** and potentially energy and CO_2 savings associated with windbreaks.
6. Promote Use of Wood Products as an alternative to energy intensive materials that emit higher levels of CO_2 during production, and to improve or maintain carbon storage rates in long life wood products or thinned stands of the forest. The supply of biomass for sustainable wood products is part of the forest management option above, and could be combined with a program to support use of sustainably grown wood products.
7. State procurement of locally grown wood products to reduce CO_2 transport emissions associated with long distance haul of products. The supply of biomass for local wood products is part of the broader forest management option, and could be combined with a program to support use of sustainably grown local wood products.
8. Improve efficiency of wood burning stoves, or fuel switching, to maximize benefits of displacing higher CO_2 emitting energy supplies such as gas, oil, or coal. Support continuing work of the Clean Air Agency.
9. Develop carbon offsets (and credit potential) for sale of agriculture, forestry and waste options in the Puget Sound region to stimulate markets for mitigation actions and encourage expanded levels of effort under greenhouse gas plans by providing flexibility mechanisms
10. Develop markets for purchase or sale of carbon offsets (or credits) from broader geographical areas to stimulate markets for mitigation actions and encourage expanded levels of effort under greenhouse gas plans by providing flexibility mechanisms
11. Afforestation and Reforestation (in-state) to increase carbon storage on forestland
12. **Protect forest, agriculture and other natural lands from conversion to other land uses** to protect carbon sequestration (CO_2 storage) and biomass flows for wood products or energy that displace alternative materials or energy source that emit more CO_2, and to avoid increased transportation CO_2 emissions associated with development that is not location efficient
Waste Management
13. Residential yard waste composting to reduce CH_4 and N_2O emissions from open composting. This strategy identified as one that merits further research to determine if there is potential. Perhaps as part of a broader waste management strategy.
14. Convert Landfill CH_4 to Energy to reduce direct CH_4 emissions and reduce CO_2 emissions by displacing higher emissions energy supplies
15. Wastewater Activities: The TWG indicated that this would be a good area for an education program, particularly including utility leadership. Key concepts might include:

▪ **Energy Efficiency Improvements of waste processing machinery and equipment** to reduce CO_2 emissions from electricity and fuel use ▪ **Lower Waste Processing Needs (lower water consumption, waste production)** to reduce CO_2 emissions from electricity and fuel use ▪ **CH4 and Biogas Energy Programs** to convert waste CH_4 to electricity production and displace higher emissions energy supplies ▪ **Install digesters and turbines** to convert waste CH_4 to electricity production and displace higher emissions energy supplies
16. Recycling/Source Reduction to reduce CO_2 emissions associated with production of products from raw materials and to reduce CH_4 emissions associated with waste disposal
17. Flare Landfill CH4 to convert fugitive CH_4 emissions to lower radiative impact CO_2 emissions
18. Resource Recovery Facility to reduce energy consumption and CO_2 emissions related to extraction and processing or raw materials
19. Install fuel cells in waste processing facilities to displace higher emissions energy supplies
Agriculture
20. **Promote "no net loss" of agricultural land** to protect carbon storage and energy crop potential, and to reduce transportation emissions associated with development that is not location efficient
21. **Install centralized manure digesters on dairy farms** to reduce CH_4 emissions and provide waste energy that can displace other higher emissions energy supplies in the power market that emit CO_2
22. **Install manure digesters on dairy farms** to reduce CH_4 emissions and provide waste energy that can displace other higher emissions energy supplies on site that emit CO_2 (If they are of an appropriate size to make economic sense.)
23. Nutrient Reductions From Soil And Fertilizer Management – Actions that reduce N_2O and CH_4 emissions from treatment and application of manure and fertilizer; these may also increase carbon content of soils. This category could involve a number of specific programs related to livestock, manure and commercial fertilizer management on pasture and croplands. This option might be elevated to high interest depending upon the availability of data and potential for GHG reductions that are found.
24. **Expand organic farming** to reduce emissions of CO_2 and N_2O from fertilizer use and potentially CO_2 emissions from farm equipment use
25. **Expand use of locally grown agricultural products** to reduce CO_2 emissions from transport of produce over long distances. Includes supporting Farmer's Markets and

institutional purchases of local grown produce
26. Educate Consumers – TWG suggested that a broader education strategy that includes the above or other options might be a good cross cutting approach.
27. Composting of waste to reduce CH4 emissions
28. Conservation tillage/No-till to reduce loss of soil carbon and reduce CO2 emissions from farm equipment use
29. Increase winter cover crops to increase carbon storage in soils
30. Reduce non-farm fertilizer use on suburban and urban landscapes to reduce N2O emissions and potentially CO2 from lawn care equipment. The group identified this a “good idea” that might be elevated to high interest depending upon the availability of data and potential for GHG reductions that are found.
31. **Ag Biomass Feed stocks for Electricity** to displace use of higher emissions energy supplies
32. **On-Farm Wind Production** to displace use of higher emissions energy supplies
33. **Change feed stocks of livestock** to reduce enteric fermentation and CH4 emissions
34. **Improve water & nutrient use** on farms to reduce CO2 emissions from machines used for water management and fertilizer application
35. **Rotational grazing/Improve grazing crops** to reduce soil carbon losses
36. **Converting land to grassland, forests, or wetland** to increase carbon storage rates
37. **Convert farm equipment from diesel to biodiesel, ethanol or LNG** to displace higher emissions diesel fuel
38. **Convert farm equipment to hybrid-electric engines** to displace higher emissions diesel fuel technologies
39. Biodiesel production (Incentives) to displace higher emissions diesel fuel technologies
40. Ethanol production (Incentives) to displace higher emissions diesel fuel or gasoline based technologies
41. Manure digesters; Use existing technologies on farms >300 cows to reduce fugitive CH4 emissions from liquid manure facilities
42. Manure digesters; Use existing technologies on farms >600 cows to reduce fugitive CH4 emissions from liquid manure facilities
43. Reduce summer fallow to increase soil carbon storage or energy cropping or waste residue production for energy feed stocks to reduce CO2 emissions from higher

emissions energy supplies
44. Use newly developed technologies for manure digesters to reduce fugitive CH4 emissions beyond known technologies

Transportation Sector

	Strategy
Vehicle Miles Traveled	
1.1	Strategies contained in PSRC's Destination 2030 will serve as the foundation strategy list for the VMT discussion. The Transportation TWG will determine how it can best add value, whether by informing the overall regional VMT discussion with technical information regarding GHG emissions, supporting specific VMT reduction strategies and/or identifying additional and/or complementary strategies. Stakeholders identified three broad categories of strategies within VMT: increasing transit; demand side management; and land use strategies.
Cars/Trucks	
2.1.1	Government procurement of low-GHG fleet vehicles
2.1.2	Procurement of low-GHG fleet vehicles (private or other)
2.1.3	Purchases of small electric vehicles for specific applications
2.2.1	Low-GHG feebates (state-specific or regional)
2.2.2	Tax credits for low-GHG vehicles
2.2.3	CO_2 –based registration fees
2.2.4	Incentives to retire or improve older, less efficient vehicles (i.e., vehicle scrappage)
2.3.1	Low-GHG tailpipe emission standards
2.3.2	LEV-2 Implementation
2.3.3	Low-sulfur diesel and complementary technologies (e.g., particulate traps)
Fuels	
3.1.1	Alternative fuel infrastructure development (e.g., pump tax to fund H_2 infrastructure)
3.1.2	Fuel Tax
3.2.1	Low-GHG fuel standard
3.3.1	Low-GHG fuel for state fleets (e.g., CNG or biodiesel)
3.3.2	Regional coordination on purchase and use of low-GHG fuels
In-Use Operation	
4.1.1	Enforce speed limits
4.1.2	Vehicle maintenance/driver training (e.g, tuning of vehicles, tire pressure)
4.1.3	Anti-idling measures
4.1.4	Add-on technologies (low friction oil, low rolling resistance tires)
4.1.5	Vehicle technology improvements (e.g., aerodynamics)
4.1.6	Increasing Low-GHG Travel Options - Flex-time
4.2.1	Freight logistics improvements/GIS/
4.2.2	Vehicle maintenance/driver training
4.2.3	Truck stop electrification
4.2.4	Anti-idling measures
4.2.5	Truck efficiency packages (compression braking, aerodynamics, tires, etc)
4.2.5	Pre-clearance at scale houses, truck climbing lanes
4.2.6	Enforce speed limits

Infrastructure Efficiencies	
5.1	Optimized static signage to indicate traffic speeds and directions for better traffic flow.
5.2	Enhanced intelligent transportation elements: variable message signs, cameras, incident response vehicles, ramp metering, and on-board vehicle trackers to identify congested areas of the highway to avoid.
5.3	Traffic signal synchronization
5.4	Grade separation of roadways for cars/trucks and rail
5.5	Emergency infrastructure backup power to keep signals and other powered traffic aids functioning.
5.6	Frequent road maintenance
5.7	Roadway material and color
5.8	Intermodal freight rail and truck initiatives (e.g., lower commuter rail wires, raise bridges to be suitable for double-stack containers)
Off-Road and Airport/Port Activities	
6.1	Incentives for purchase of efficient vehicles/equipment/electrification
6.2	Improved operations/operator training
6.3	Tax reductions for biodiesel (and/or 2007 fuels?)
6.4	Maintenance improvements
6.5	Increased use of alternative fuels or low sulfur diesel
6.6	Airport ground equipment – incentives to purchase of AFVs and fuel
6.7	Improved logistics efficiencies
6.8	Switch-engines – cleaner marine engines
6.9	Integrated aviation, rail, bus networks
6.10	Ferry system (could include vehicle traffic management, ferry operations, emission control technology, etc.)
6.11	Shore power plug-in shipping containers
6.12	Shore power plug-in freight loading

Electricity Supply GHG Reduction Strategies

1. **Renewable Portfolio Standards (RPS)**, are in place in over a dozen states, and have proposed to the WA legislature. For instance, recent legislation suggested 15%/ of 2023 loads from qualifying renewables with tradable credits and a cost cap.
2. **Public Benefit Charge (PBC) Funds** are collected as surcharge on utility bills, and are typically directed to a mix of energy efficiency, renewable energy, and low-income programs. Some states maintain both a PBC and an RPS.
3. **Incentive Policies and Barrier Reduction** for **Combined Heat and Power (CHP)** could include establishment of interconnection standards, appropriate tariff structures, output-based environmental regulations that reward CHP's efficiency benefits, tax credits/exemptions, and/or accelerated depreciation.
4. **Greenhouse Gas Cap and Trade** involves setting a limit for state/regional power plant emissions, allocating emissions allowances, and enabling trading among participants, often with built-in cost limitations. The group will explore possible integration with other states, including the systems being designed for the Northeast US and Europe.

5. **Tax and Non-tax Credits and Incentives for Renewable Energy** could be directed to specific applications such as solar photovoltaic systems, as recently proposed to the WA legislature.
6. **Barrier Reduction for Clean, Distributed Generation** could include better interconnection rules, reduction of transmission barriers for remote and intermittent renewables (see also CHP measure above)**.**
7. **Utility-wide Generation Performance Standards** could be considered as part of a cap and trade system described above, especially to limit purchases of higher emissions electricity from out-of-state/region sources. For instance, a target emissions rate or % reduction in a utility's overall CO_2/MWh
8. **GHG mitigation requirements for EXISTING power plants**, is similar but more limited in scope to the cap and trade strategy above.
9. **Integrated Resource Planning** with explicit carbon risk accounting is considered a useful overall framework.
10. **Load management, pricing and metering strategies (e.g. time of use rates)** has unclear implications in terms of GHG emissions. Advice from Power Council will be sought.
11. **Transmission & Distribution Line Loss Reduction** is being pursued by some utilities and may be investigated further
12. **Sulfur Hexaflouride Management Programs** would aim to limit the losses of this highly potent heat-trapping gas used for transformer and other utility applications.
13. **Educating Hydro Utilities and Suppliers** regarding the risks of climate change is viewed as very important since climate change will likely entail significant changes in the timing and magnitude of streamflows.
14. **Efficiency Improvements and Repowering Existing Plants** is viewed as a long-term strategy especially relevant for hydroelectric facilities that would need adapt to climate-related changes in the hydrograph. Group suggested this be incorporated with the hydro utility education option above.
15. **Natural Gas leakage reduction programs** can reduce fugitive methane emissions from pipelines and storage facilities, and may be investigated further.
16. **Negotiated Agreements** between utilities and regulators/government might be a strategy worth exploring later.
17. **Mandatory or voluntary reporting of fuel use, GHG emissions** is a CPAC-wide strategy this group views as valuable.
18. **Green Power Marketing** is also being considered by the B&F group from the purchasers' perspective.
19. **Voluntary Utility CO_2 Targets and/or Trading,** include examples such as the Seattle City Light target and the Chicago Climate Exchange, which allows trading among participating companies. Group considered this as a possible component or step in a Utility sector GHG Cap and Trade strategy, which was identified as a high priority.
20. **Emergency generators** could reduce emissions by using cleaner fuels or selling excess generation back to the grid. Group agreed that this is a good idea, but a low priority for analysis.
21. **GHG mitigation requirements for NEW power plants** are viewed as a key strategy, and is now established in legislation.
22. **CO_2 Tax** are not viewed as a viable option..
23. **Support for Wind and Solar Development (**zoning, siting, etc.) is viewed as an important state-wide issue, but low for the Puget Sound region, and specific policies to evaluate are not clear..

24. **Waste to Energy** options, such as digesters and sewage treatment methane capture. Group believes it to be a good idea, but recognizes it is being pursued by the AFSW group, and will be followed here..
25. **Landfill Gas Recovery and Generation** is covered by AFSW group
26. **Net Metering** is already established in WA.
27. **Brownfield Re-development** is not viewed as very promising for the region as an electricity supply option.
28. **Environmental (emissions) Disclosure** is covered adequately by the reporting/registry option above.
29. **Fuel Cell Development Incentives** and demonstrations can be considered for their long-term potential.
30. **Research and Development (R&D)** is a similar long-term option.
31. (Advanced) Biomass generation. This and the following few technology-specific items were not considered promising for the region under the CPAC timeline. However, these items may be considered as part of the broader strategies described above (means to achieve regional renewable standards, etc.)
32. **Biomass Co-firing at Coal Plants**
33. **Research and Development (R&D)**
34. **Carbon Capture and Sequestration**
35. **Combined H2/electricity production from fossil fuels with sequestration**
36. **Advanced fossil technologies (e.g. IGCC)**
37. **Nuclear Plant Relicensing and Uprating**

APPENDIX F – Emission Inventory Information

Inventory of Greenhouse Gas Emissions, Puget Sound 2000

Sector	GHG Emissions (MMTCO2e) 2000
Buildings, Facilities	
Direct fuel use and process emissions (excluding electricity)	
Residential	3.1
Commercial	2.7
Industrial - energy	3.5
Industrial - process emissions	1.5
Sub-total	**10.7**
Electricity Supply	
Allocated to sectors by sectoral electricity sales	
Residential	3.4
Commercial	2.9
Industrial	1.6
Sub-total	**7.9**
Transportation	**23.7**
Agriculture, Forestry and Solid Waste	**5.1**
Total	**47.5**

Note: HFC emissions from vehicle air conditioning are included in transportation. All other non-energy emissions are included with the industrial sector including HFC emissions from non-vehicle air conditioning

Will the Northwest notice a changing climate?

Philip Mote

University of Washington

The Climate Impacts Group

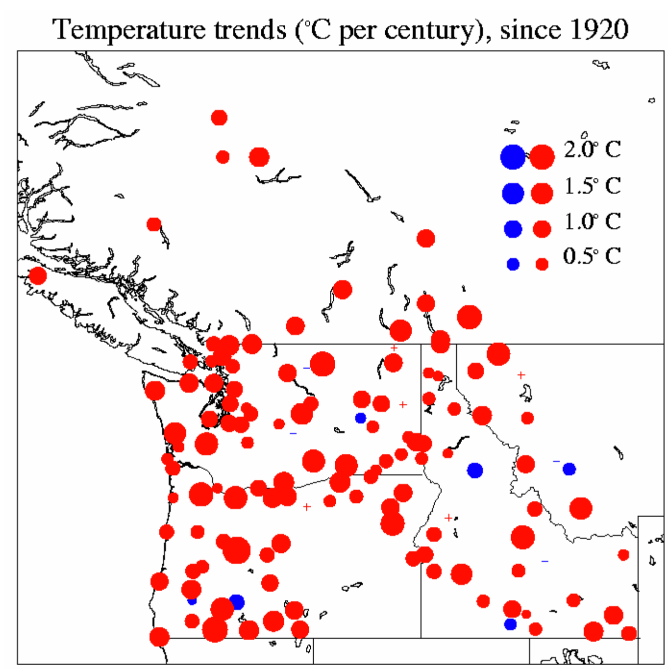
http://jisao.washington.edu/PNWimpacts/

Goal: help the Pacific Northwest become more resilient to climate variations and climate change

Supported by NOAA Office of Global Programs

Outline

- Science of global climate change
  - how we know Earth is warming
  - why we believe the warming is not natural
- Projections of future climate
  - globally
  - for the Northwest
  - some impacts



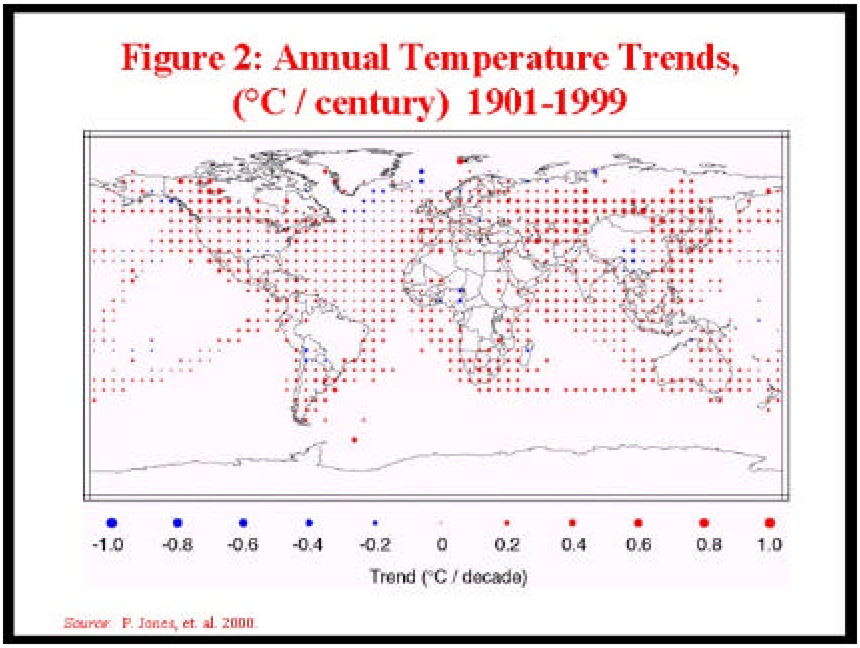
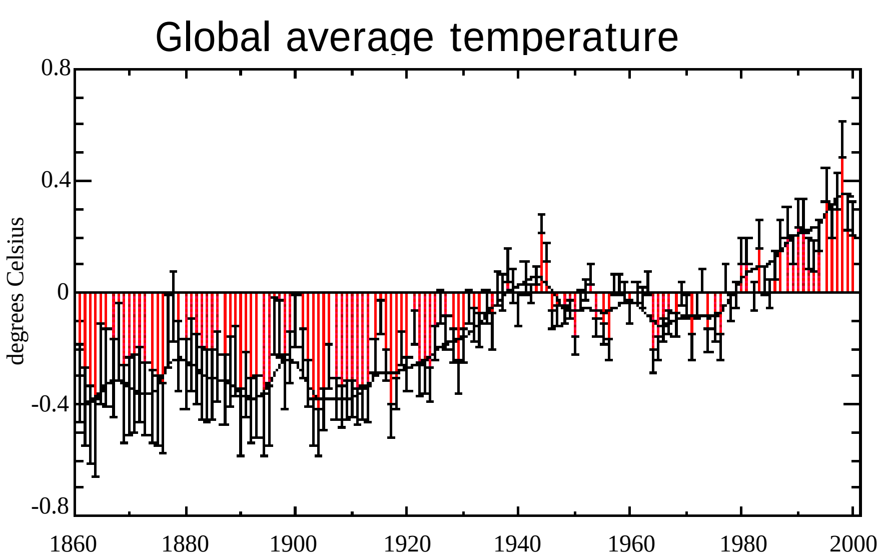
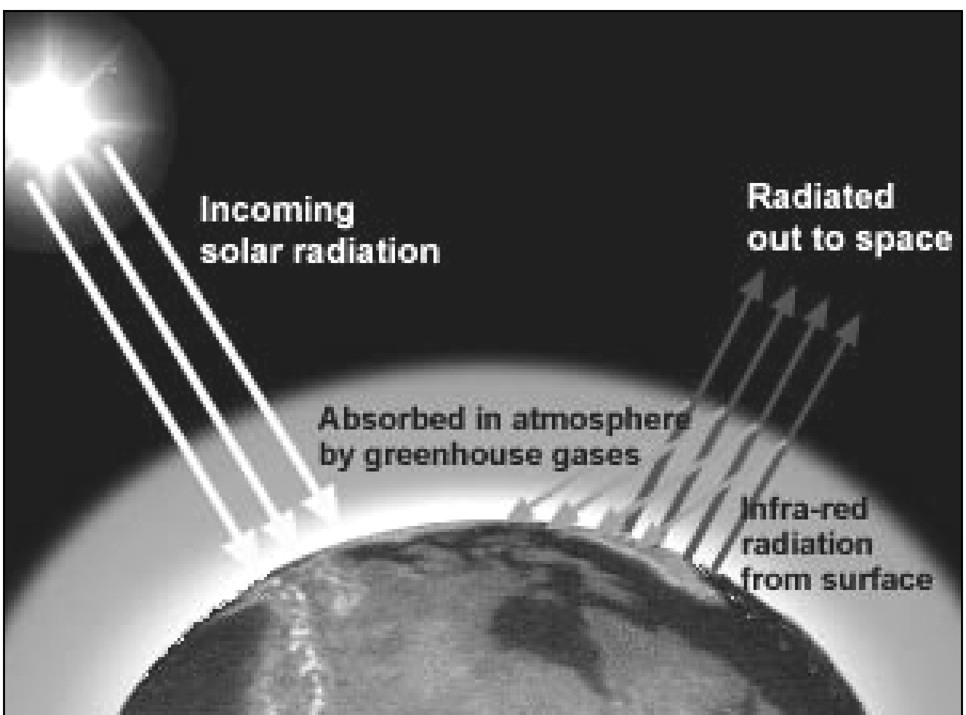


Figure 2: Annual Temperature Trends,
(°C / century) 1901-1999
-1.0
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1.0
Trend (°C / decade)
Source: P. Jones, et. al. 2000.

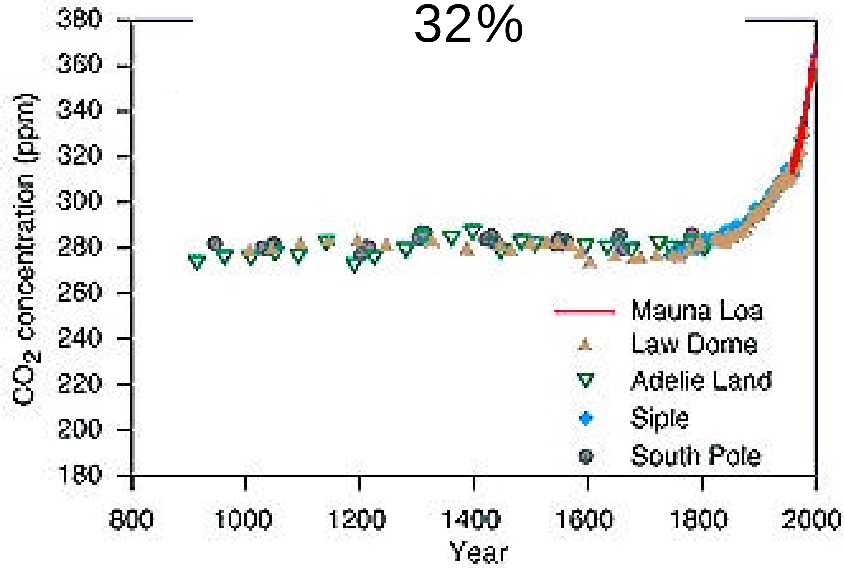

Global average temperature
0.8
0.4
0
-0.4
-0.8
degrees Celsius
1860
1880
1900
1920
1940
1960
1980
2000

Science of climate change

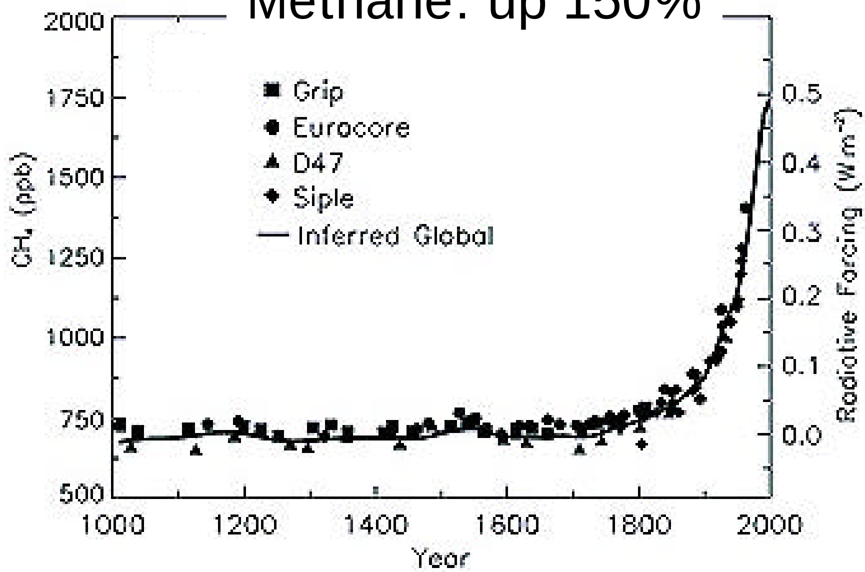
- Thousands of peer-reviewed scientific papers
- Intergovernmental Panel on Climate Change (IPCC)
- Major reports in 1990, 1996, 2001
- Conclusions:
  - "An increasing body of observations gives a collective picture of a **warming world** and other changes in the climate system."
  - "There is new and stronger evidence that **most of the warming** observed over the last 50 years is attributable to human activities."



Carbon dioxide: up 32%



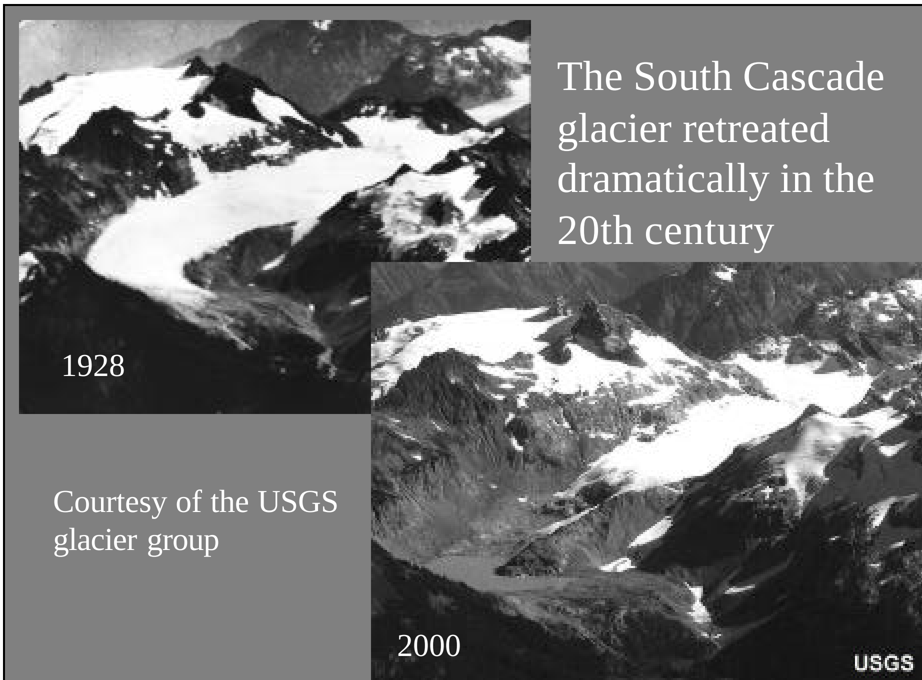
Methane: up 150%



Some evidence that Earth is warming

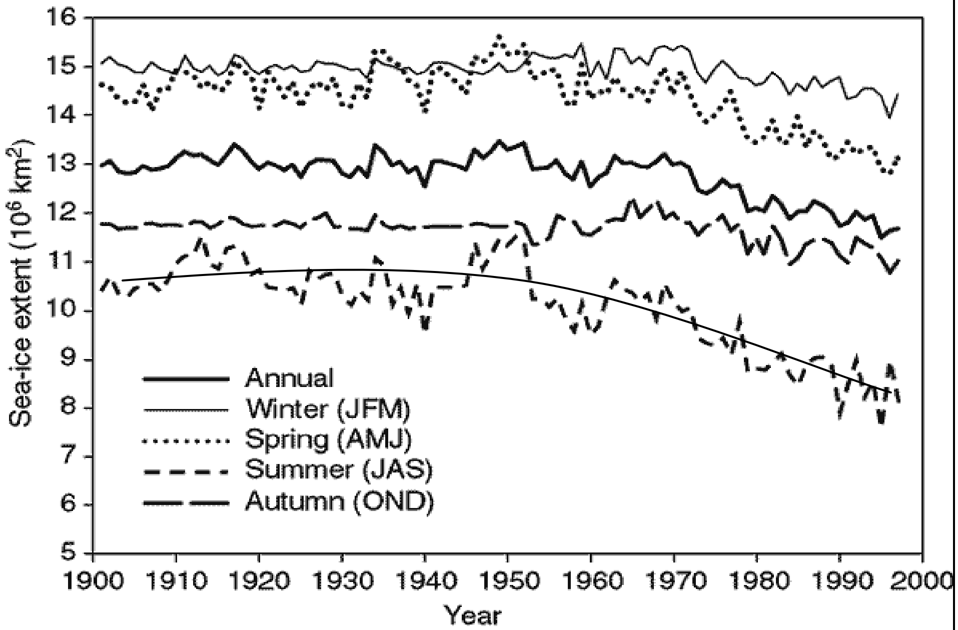
- Direct measurement: up 0.6°C
- Permafrost, glaciers melting
- Arctic ice thinning
- Springtime coming earlier (hydrological and phenological indicators)

The South Cascade glacier retreated dramatically in the 20th century

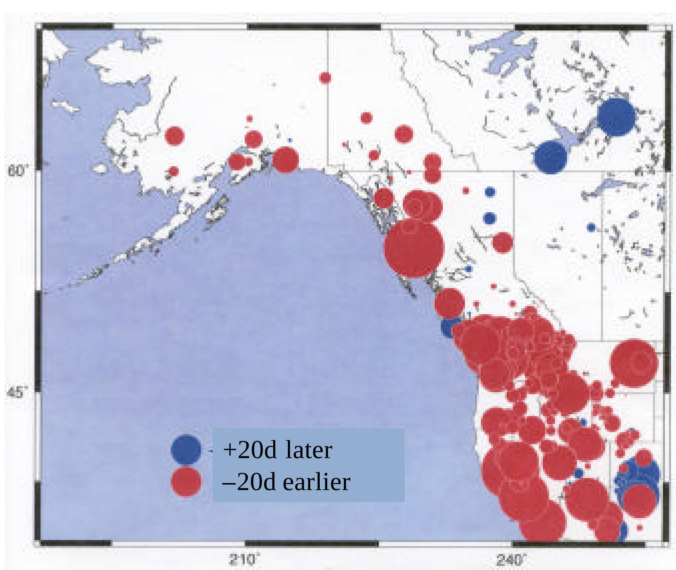


Courtesy of the USGS glacier group

Arctic sea ice

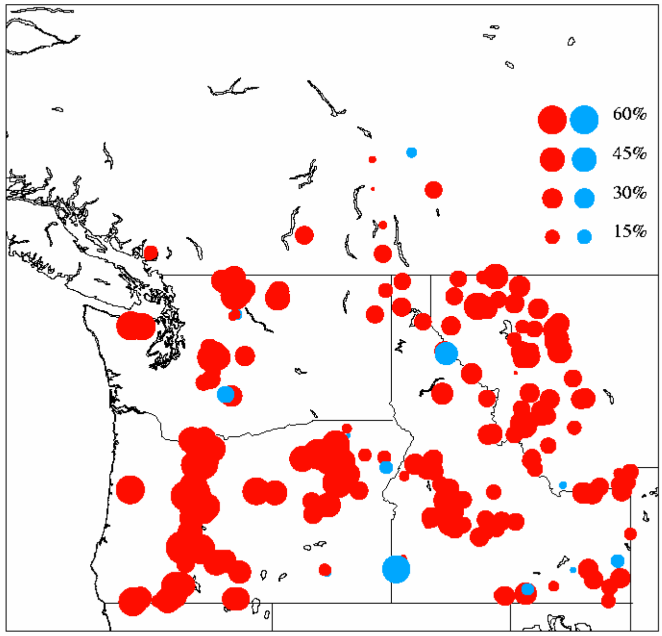


Trends in timing of spring snowmelt (1948-2000)



Courtesy of Mike Dettinger, Iris Stewart, Dan Cayan

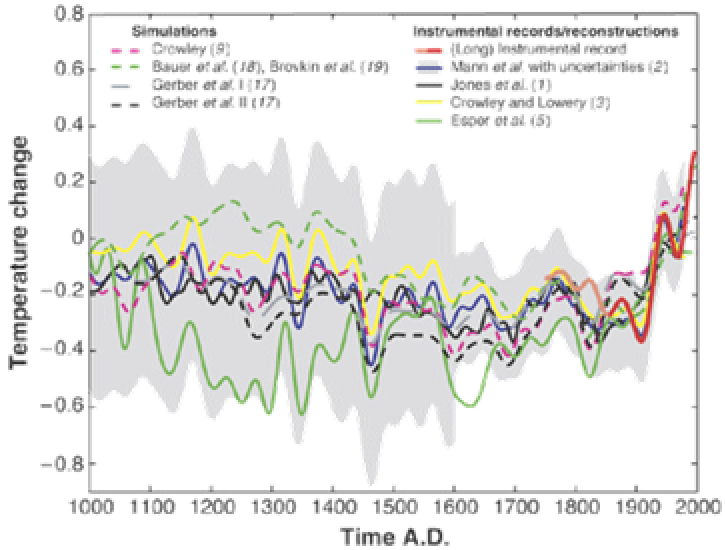
Trends in April 1 snow water equivalent, 1950-2000



Some evidence that it’s not natural

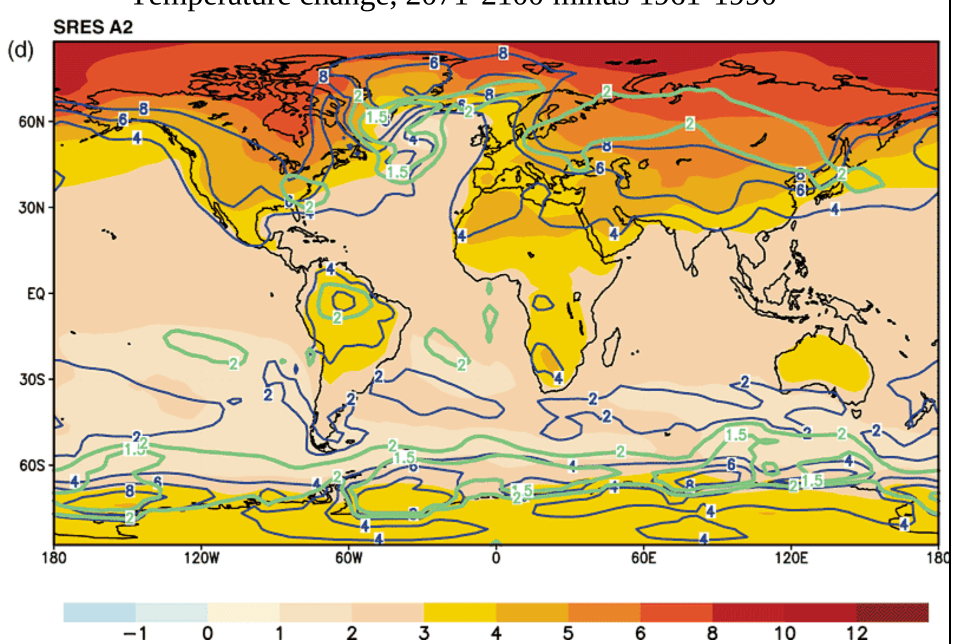
- Rate of change appears to be unusual
- Pattern of change matches that expected from increasing greenhouse gases
- Solar, volcanic forcing would have led to cooling in the past ~30 years

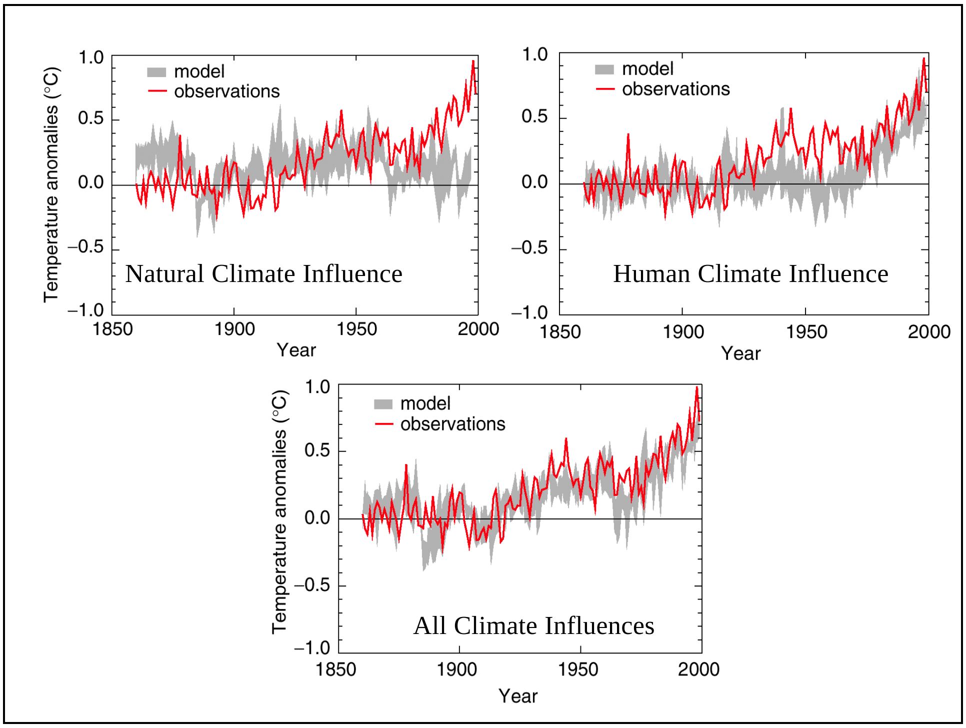
Long-term context

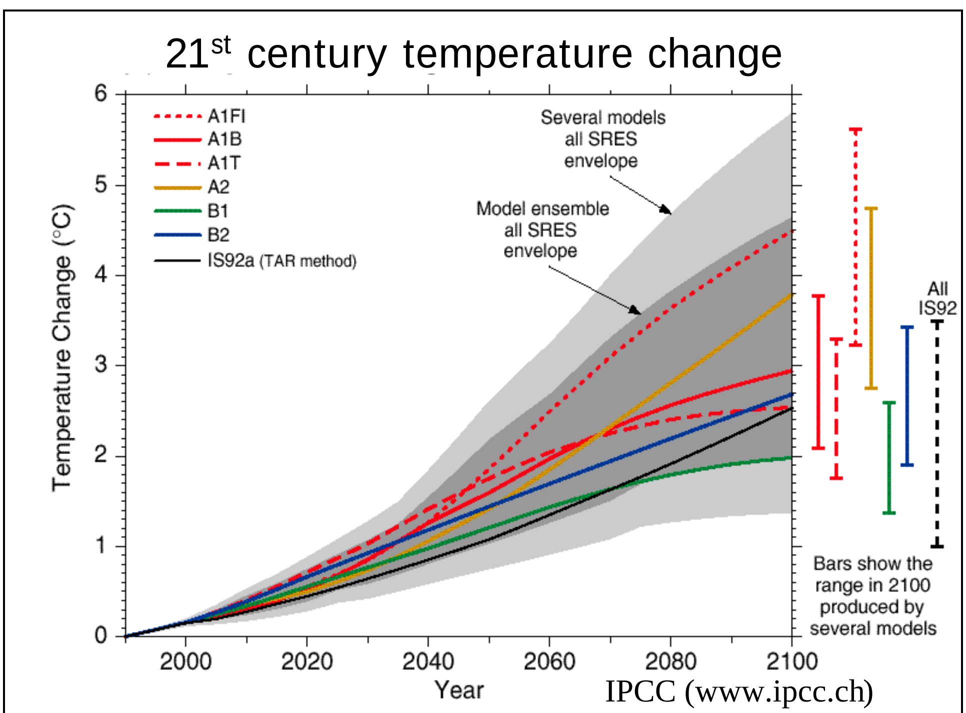


source: Mann et al., EOS

Temperature change, 2071-2100 minus 1961-1990



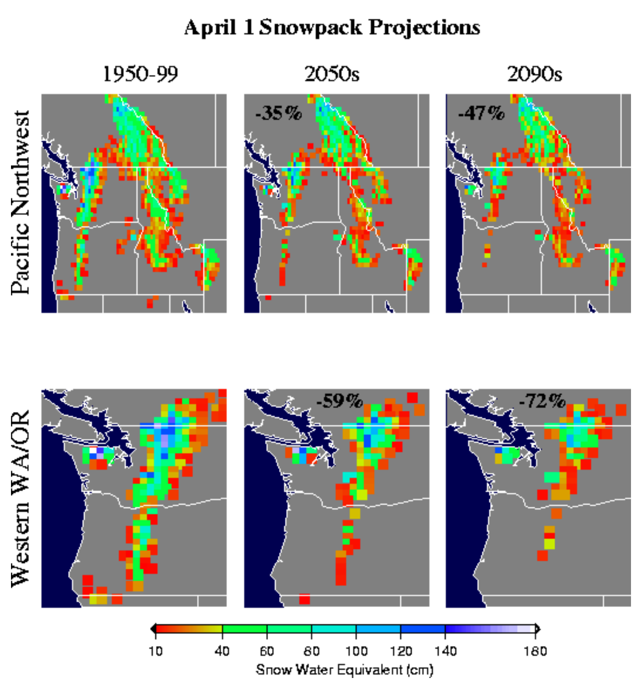

1.0
0.5
0.0
−0.5
−1.0
model
observations
Natural Climate Influence
Human Climate Influence
All Climate Influences
Temperature anomalies (°C)
1850
1900
1950
2000
Year


21st century temperature change
A1FI
A1B
A1T
A2
B1
B2
IS92a (TAR method)
Several models all SRES envelope
Model ensemble all SRES envelope
All IS92
Bars show the range in 2100 produced by several models
Temperature Change (°C)
0
1
2
3
4
5
6
2000
2020
2040
2060
2080
2100
Year
IPCC (www.ipcc.ch)

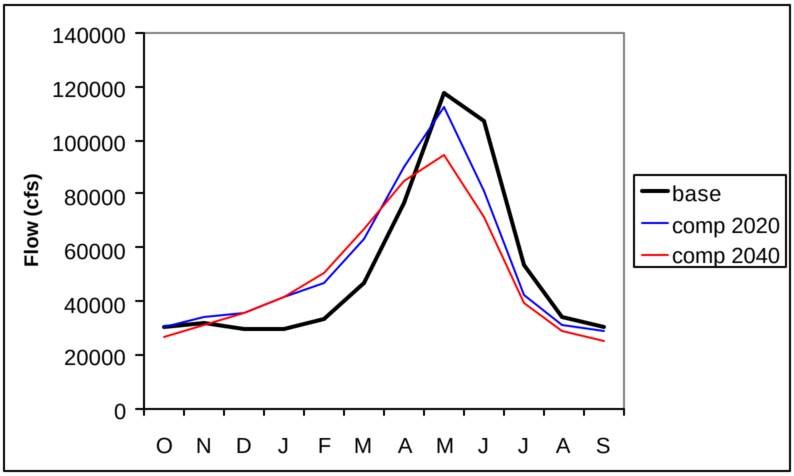
A range of climate change scenarios for the Northwest

	temperature		precipitation	
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar
low	1.5°C	1.1°C	-4%	0%
mean	2.1°C	2.0°C	+4%	+8%
high	3.3°C	3.7°C	+9%	+22%

Estimated climate change from 20th c. to 2040s using 8 climate model scenarios.



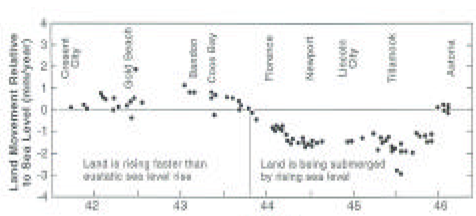
Snake River at Ice Harbor

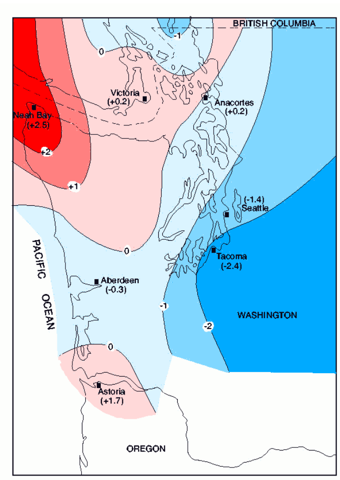


Reduced summer flows ==> shortages for irrigation, fish, hydro;
less concern over flooding
Increased winter flows ==> more hydro production

Vertical Land Movement

- Tectonic forces move the land
- Rising sea levels add to the land movement
  - Current rise: 1.0-2.5 mm/yr
  - Projected rise: 2.0-8.6 mm/yr
    - Shoreline change ~10 mm/yr





Impacts of climate change on the PNW

Highest confidence:

Models: warmer; higher snow line

•summer water supply, drought

•demand for water

•conflicts over water resources

•winter streamflow increases in snowmelt-driven basins

energy production

•coastal flooding, inundation

•salmon freshwater survival

Conclusions

- Earth (and the NW) is warming as a result of human activities, and this warming will continue
- Some consequences are already becoming apparent (reduced snowpack, earlier freshets)
- Changes in other aspects of climate are likely but less foreseeable

APPENDIX H – Summary Table

Recommended Strategies, Emissions Savings and Cost (Critical Action Areas in Bold)

Strategy	GHG Savings (MMTCO2e) 2010	GHG Savings (MMTCO2e) 2020	Mitigation Cost ($/MtCO2)	Net Costs (million 2002$) 2010	Net Costs (million 2002$) 2020	Net Costs (million 2002$) NPV
Buildings and Facilities						
Enact Appliance Efficiency Standards	**0.15**	**0.30**	**-$54 (Neg)**	**-$13**	**-$29**	**-$152**
Upgrade Non-Residential Building Code	**0.01**	**0.04**	**(Neg)**			
Incent Low GHG Building Design	0.21	0.85	(L-M)			
Achieve Full, Sustained Support for Efficiency Programs via PBC or EPS	**1.20**	**3.14**	**-$34 (Neg)**	**-$41**	**-$108**	**-$555**
Promote Fuel Conversion to Lower GHG Emissions	0.02	0.05				
Provide Tax/Other Incentives for Low-GHG Purchase and Design						
Reduce Cement-related Emissions	0.05	0.09				
Support Building Recommissioning						
Reduce HFC Use and Leakage						
Lower Energy Use at Water/Wastewater Facilities						
Provide Commercial Bldg Operator Training						
Provide Industrial Energy Mgmt Training						
Subtotal Buildings and Facilities	***1.63***	***4.47***		***-$55***	***-$137***	***-$707***
Electricity Supply						
Support Combined Heat and Power Applications	0.39	0.79	-$8 to $25 (Neg-M)	-$5 $17	-$11 $32	-$66 $204
Enact Renewable Portfolio Standard (or Public Benefit Charge for Renewables)	**0.61**	**1.87**	**-$5 to $11 (Neg-M)**	**-$1** **$16**	**-$33** **$33**	**-$72** **$171**
Establish GHG Emission Cap and Trade System for Electricity Suppliers	**0.22**	**0.81**	**~$5**	**$17**	**$4**	**$18**
Subtotal Energy Supply	***1.22***	***3.47***		***$10*** ***$49***	***-$40*** ***$70***	***-$120*** ***$393***
Transportation						
Adopt California LEV II Emission Standards	**0.01**	**0.14**	**$14**	**$1**	**$0**	**$4**
Adopt California (Pavley) GHG Emission Standards	**0.18**	**2.96**	**-$126**	**-$11**	**-$439**	**-$1,175**
Adopt Fee/Rebate System for Vehicle Efficiency	0.00	0.00				
Seek Reduced Diesel (Black Carbon) Emissions						
Improve Freight Efficiency	0.06	0.14	$37 - $105			
Procure Low-GHG Fleet Vehicles						
O&M and Add-on Measures for Existing Vehicles						
Reduce Vehicle Miles Traveled Through						
- Location Efficient Plans	**0.24**	**0.73**				
- Increased Use of Public Transit	**0.10**	**0.29**				
- Various Demand Side Measures	**0.20**	**0.59**				
Subtotal Transportation	***0.79***	***4.86***		***-$10***	***-$439***	***-$1,171***
Agriculture, Forestry, and Solid Waste						
Protect forest, agricultural, and other natural lands from conversion	**0.84**	**0.84**	**-$7** **$7**	**-$6** **$6**	**-$6** **$6**	**-$59** **$59**
Increase contribution of biomass to power supply	0.22	1.09				
Manage private non-industrial forests	0.34	0.34	$0.01	$0	$0.004	$0.045
Replace hardwoods with softwoods						
Restore riparian ecology in industrial forests	0.28	0.28	$0.2	$0	$0.07	$0.68
Protect and enhance urban forests						
Compost yard waste						
Capture and use landfill methane		0.17				
Install centralized manure digesters	0.09	0.09				
Provide carbon offsets through above strategies	*included in above estimates*					
Increase recycling and waste reduction	0.56	1.05				
Subtotal AFSW	***2.33***	***3.85***		***-$6*** ***$6***	***-$6*** ***$6***	***-$58*** ***$60***
Grand Total	5.97	16.64		***-$60*** ***-$9***	***-$621*** ***-$501***	***-$2,056*** ***-$1,425***

Appendix I: Buildings and Facilities Strategy Analyses

This appendix represents the results of the supporting technical analysis, as guided by the Buildings and Facilities Technical Working Group. The individual strategies are discussed in the following groupings:

> **SUBGROUP A: Efficiency and fuel switching programs:** BF1 (Energy Portfolio Standard), 2 (Public Benefit Charge), 7 (Residential Potentials), 9 (Commercial Potentials) , 14 (Industrial Potentials).
>
> **SUBGROUP B: Tax and other incentives (design assistance, permitting, etc):** BF 4 (Tax incentives), 8 (Residential Low GHG design) , 10 (Commercial Low GHG design).
>
> **SUBGROUP C: Codes and Standards:** BF 6c (Building Code Upgrades) and 3 (Appliance Standards).
>
> **SUBGROUP D: Training, education, and enforcement.** BF 6a/b (Building Code Enforcement, Building Official Training), 12 (Training Building Operators), 16 (Energy Management Training).
>
> **SUBGROUP E: Specialized strategies.** 5 (HFCs), 11 (Recommissioning), 13 (Water/Wastewater Treatment), 15 (Cement).

Strategy overlaps and avoiding double counting:
Several of the measures could potentially cause the same changes – for example, appliance standards, building codes, low GHG design, and a public benefits fund could all result in more efficient lighting installed in new buildings. Therefore, if we looked at each strategy in isolation, we would end up double-counting some energy savings and emission reductions. Without very detailed modeling, it is difficult to precisely correct for these effects. Therefore we have adopted some rough corrections as follows.

1. We estimate the energy savings for each measure as if it were the only measure being applied. These energy savings are reported as "gross energy savings" in the sections for each measure.
2. To estimate overlapping savings as well as to chart combined energy savings (see Figure 1 and Figure 2), we assumed the following "order of implementation" for the measures: appliance standards, building code standards, low GHG building design, efficiency program potentials (PBF / EPS), then combined heat and power (a related Energy Supply strategy). This order is only used for a calculation of total emission reductions.
3. We then estimate the required deduction of energy savings from one measure on the gross energy savings from the subsequent measure. For example, we estimate that 40% of the energy savings resulting from low GHG commercial design (LEED standard) would also be achieved by adopting improved commercial building codes. Because we

rely on a range of data sources for this analysis, we consulted with experts[1] and reviewed lists of the technologies impacted by the measures to arrive at the factors as shown in Table 1.

Table 1. Accounting for Strategy Overlaps

Fraction of *Appliance Standard* savings deducted *from Efficiency Program Potentials (PBF/EPS)*	50%
Fraction of *Building Code* savings deducted *from Efficiency Program Potentials (PBF/EPS)*	50%
Fraction of *Low GHG Building Design* savings* *deducted from Efficiency Program Potentials (PBF/EPS)*	50%
Fraction of *Low GHG Building Design* savings* deducted *from Building Code savings* (Commercial sector only)	40%

* Electricity savings from commercial sector Low GHG design are included within the NW Power and Conservation Council estimates we have used. Therefore, these savings were completely removed (100%) from the efficiency program potential estimates.

Summary of results:
Based on the estimated energy and emission savings, and the strategy interactions described above, we estimated combined effects on projected electricity and natural gas demand, as shown in Figures 1-3 below. We have not yet estimated the combined emissions reductions or direct economic impacts – the former would be relatively straightforward, while latter still requires further cost analysis for some of the strategies. It does appear however that most of the strategies shown yield significant economic benefits, while low GHG building design and combined heat power (ES strategy) are appear closer to "breakeven".

Key assumptions and findings include:

- Projected electricity and natural gas demand (without new conservation activity) is drawn from the input provided by the four regional utilities.

- Together, electricity savings from the four main B&F strategies shown appear to have the potential to roughly match expected load growth through 2020.

- Demand for natural gas is expected to grow more quickly than for electricity, energy savings potential appears somewhat more modest. As a result, natural gas use and emissions are expected to grow significantly even with the strategies thus far considered.

- When combined heat and power is added to the mix, and implemented rather extensively (about 450 aMW by 2020), net regional electricity demand could actually drop, while the added natural gas demand could be roughly equal to the gas savings from the other measures considered. (The net emissions reductions could nonetheless be significant)

[1] For example, Steve Nadel (ACEEE) advised the NY process which adopted the same assumed 50% "overlap" of appliance standards with utility program potential.

- Projected utility conservation activity (shown with the dark blue dotted line) represents a significant fraction of overall electricity reductions achievable by the various measures. For gas, the projected savings do not appear as significant, in part because a significant.

- Demand by direct market electricity customers (about 3% of regional electricity demand and 6% of current electricity emissions) are not represented here. The TWG may wish to consider strategies aimed at reducing these emissions.

Figure 1

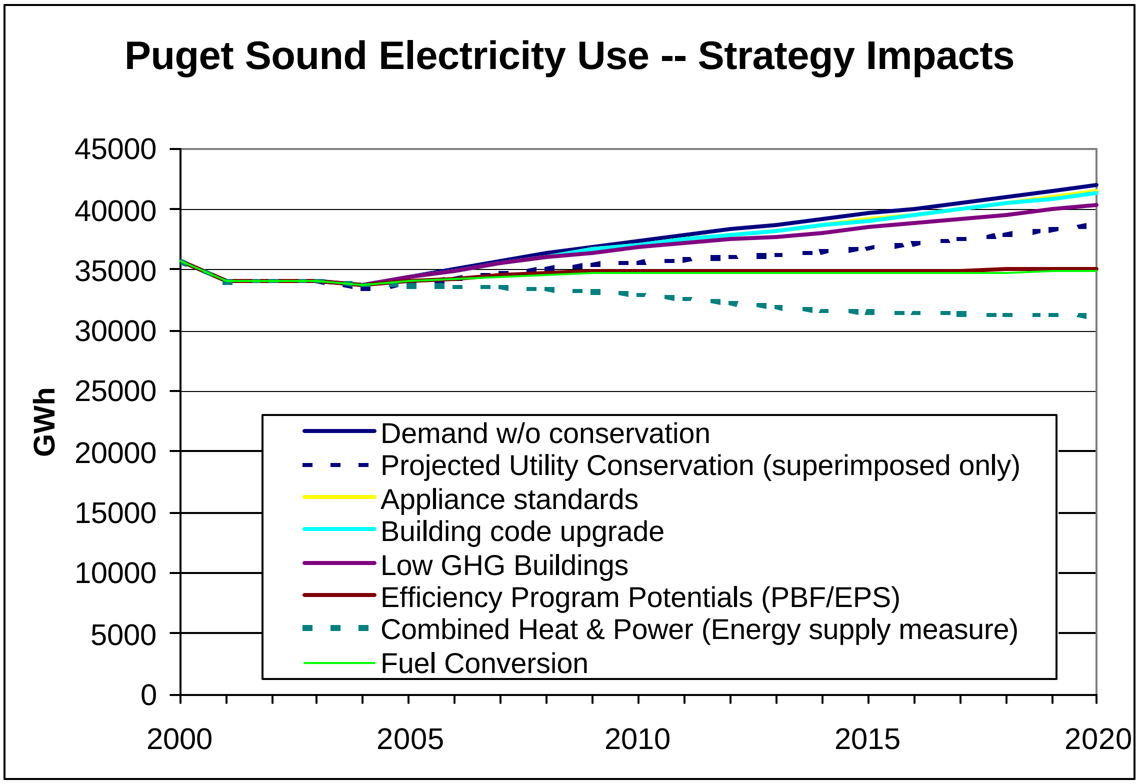


Figure 2

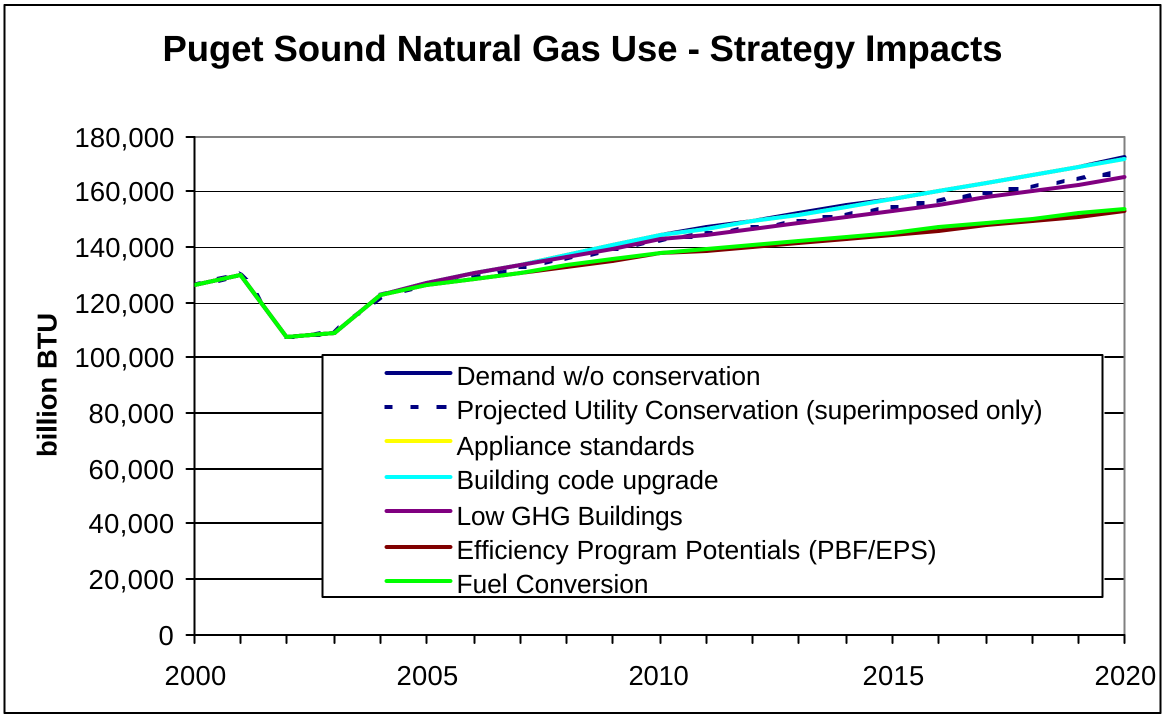
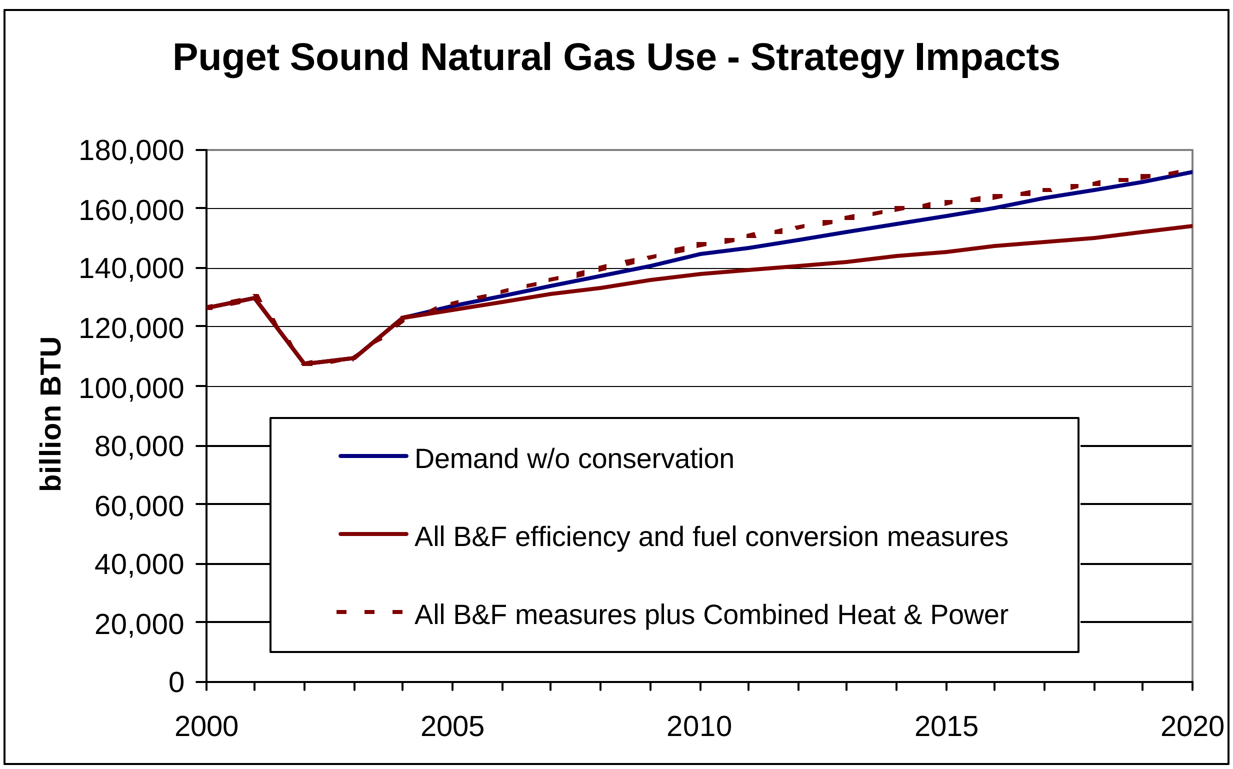


Figure 3. Puget Sound Natural Gas Use – impact of Combined Heat and Power



SUBGROUP A: Efficiency and fuel switching programs

BF1. Efficiency Portfolio Standards (EPS)
BF2. Public Benefit Charge (PBC) Funds (for energy efficiency)
BF7. Residential Energy Efficiency and Fuel Switching Opportunities
BF9. Commercial Energy Efficiency and Fuel Switching Opportunities
BF14. Industrial Retrofits, Upgrades, Optimization, and Fuel Switching

Policy/Program Description: The following two strategies provide alternative means to achieve similar goals: full, sustained support for energy efficiency (and fuel switching) programs over the next 15 years and beyond to enable them to capture their full, achievable cost-effective potentials (as described in assessed for strategies BF 7, 9, and 14). These programs include the types of utility conservation programs for which Puget Sound electric and gas utilities have become recognized national leaders, as well as market transformation activities run through the NW Energy Efficiency Alliance. We describe the two options here, then analyze their potential energy savings, GHG reductions and costs of energy efficiency programs in general in a common framework.

> **Public Benefit Charge:** Public benefit charge funds are in place in about 15 states[2], typically adopted as part of electricity restructuring policy/legislation. These funds are collected as surcharge on utility bills, and are typically directed to a mix of energy efficiency, renewable energy, and low-income programs. For example, in Oregon, the Senate Bill 1149 included a 3% system-benefits charge to apply to Portland General Electric and Pacific Power ratepayers in the state. The Oregon Public Utility Commission encouraged the creation of the Oregon Energy Trust, a non-profit organization to administer the fund. The fund, expected to be about $45-$50 million annually, is allocated among school energy efficiency and renewable resource activities; Energy Conservation and Market Transformation; New Renewable Energy; low-income weatherization; and Housing and Community Services grants.

Table 2. Examples of Public Benefit Funds for Energy Efficiency in Nearby States

Fund	Charge	Notes
California Public Goods Charge	1% elec 0.7% gas	http://cpuc.ee.support.net/ee/About/Funding/Funding.htm
Oregon Energy Trust	3% elec and nat gas	Funding allocations: 1) Energy Conservation and Market Transformation, 63%; (2) New Renewable Energy, 19%; (3) low-income weatherization, 13%; and (4) Housing and Community Services grants, 5%. http://www.energytrust.org
Montana System Benefits Charge	1.1 mills	

[2] e.g. California, Connecticut, Delaware, Illinois, Maine, Massachusetts, Minnesota (just renewables), Montana, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island (mostly renewables), Wisconsin, and Vermont.

Efficiency Portfolio Standard: An efficiency portfolio standard would require utilities to meet a certain fraction of their retail loads through conservation and related investments, if cost-effective. An efficiency portfolio standard represents an alternative to a public benefit charge, as means to systematic support continued funding of energy efficiency over time. Many utilities may already be investing in conservation at levels consistent with an EPS or a public benefit charge – what these measures provide is a means to ensure stable commitments (EPS) or funding levels (PBC) over time.

An efficiency portfolio standard was included in a recent Washington legislative proposal (HB 2333), which required affected entities to meet from 0.75-0.85% of retail load annually through conservation programs, which could include BPA, NEEA, and cogeneration investments, so long as investments are found to be cost-effective. Provisions of the bill were as follows:

Table 3. Energy Portfolio Provisions of HB2333

Affected entities	• Electric utilities with >25,000 meters and >7 customers/mile of line • Direct service industries • Market customers
Efficiency targets	• Annual acquisition of 0.75% of 2004 retail sales starting 1/1/05 • Annual acquisition of 0.85% of trailing-year retail sales starting 1/1/10, on 3-year period
Eligible efficiency resources	• Conservation defined as "increases in the efficiency of energy use, production or distribution." Can include BPA and NEEA investments. • High efficiency cogeneration

The key similarities and difference between a Public Benefits Fund and an Efficiency Portfolio Standard are presented in the following section, taken from the June 23 CPAC meeting. The sense of the CPAC was that, given the complexities, *not to make a choice between the two* in the context of the current process.

Comparing Portfolio Standards and Public Benefit Charges

Portfolio Standards and Public Benefits Charges have the common goal of promoting renewable energy technologies or energy efficiency beyond levels expected under current market structures.

- Portfolio standards set target levels for electricity retailers, typically in terms of the percentage of load provided by specific resource types, and allow some flexibility in how these targets can be met. Two standards are under consideration here:
  - A Renewable Portfolio Standard (RPS), which would require electricity suppliers to deliver a certain percentage of electricity from qualifying renewable resources, or to purchase credits from other suppliers who exceed their targets.
  - An Efficiency Portfolio Standard (EPS), which would similarly require electricity suppliers to save a certain percentage of electricity through efficiency programs and investments.

- Public Benefits Charges are included in electricity or gas bills and are collected by utilities. The PBC is typically a small charge, on the order of a tenth or three tenths of a cent per kWh. The administering agency (utility or central administrator) then invests the funds in renewable technologies and/or energy efficiency programs. The following table highlights the key differences and potential complementarities between the two approaches.

Aside from differences in implementation/administration costs, both approaches should yield similar economic impacts and co-benefits (fuel diversity, natural gas price benefits, jobs, bill savings for efficiency, air pollution reductions, etc.) to the extent they achieve similar levels of investment.

	Portfolio Standard	Public Benefit Charge
Key Attributes	• **Mandated target approach using a flexible, market-based mechanism.** • **Goal-oriented**: Delivers desired levels of efficiency or renewables, but with uncertain price impacts. (Can include price caps to address price uncertainties.) *Major uncertainty is cost.*	• **Central fund approach allowing flexibility in future investment patterns.** • **Price-certain:** Price impacts are defined by the level of charge (X mills/kWh), but the amount of efficiency or renewables acquired is uncertain. (Charges can be altered, but not easily.) *Major uncertainty is level achieved..*
Design Questions	• Setting appropriate/ achievable goals • Determining qualifying resources (new vs. existing), etc.	• Setting appropriate/ acceptable charge levels • Allocating funds among target programs and technologies
Flexibility	• RPS: Tradable renewable energy credits. • EPS: Ability to gain credit by investing in regional activities (Northwest Energy Efficiency Alliance, BPA programs, etc.) or through combined heat and power.	• Can easily shift priorities among technologies and programs as conditions change.

Universality (small/large, IOU/COU)	*No discernable differences?*	
Administration & Implementation	• By UTC and municipalities • Implementation by Retail electricity providers (utilities)	• Administration and implementation by Central agency (i.e. OR Energy Trust) and/or utilities
Compliance & Verification	• RPS: Requires tracking system for generation attributes or certificates (can be modeled after other states) • EPS: Requires tracking system coupled with monitoring and verification. (No direct models available, could be adapted from demand-side management experience.)	• Oversight on proper use of funds by UTC or municipalities
Impact of Surplus Conditions (Note: meaning of "surplus" deserves further consideration)	• Financial loss or gain depending on whether surplus power is sold for more or less than cost. • Possible added risk and/or financing costs • Exemptions for surplus utilities are possible.	• Similar to portfolio standard, except funds can be banked or used for other purposes if cost impacts are unacceptable
Lowest cost vs. emerging technologies	• RPS: Typically focused on lowest-cost commercial technologies (e.g. wind, geothermal, small hydro), but many jurisdictions include technology-specific targets. This can ensure resource diversity and help commercialize solar PV and other resources	• PBCs often support emerging, smaller-scale and non-electricity renewables applications. (e.g. solar PV, solar water heating, biogas, etc.)
Other Issues	• RPS: Renewable credit markets can create surplus for low-cost suppliers (adding to consumer costs), but competition can drive down costs.	• PBC funds can be diverted by state government to unrelated spending or budget shortfalls if not adequately protected.
Experience to Build Upon	• RPS: 15 states have one • EPS: WA would be the first	• Over 20 states have a PBC.
Potential for Complementarity (i.e. benefits of implementing both policies)	• Renewables: RPS and PBC can be implemented in tandem as is the case in several states (e.g. CA, NJ, MA). PBC funds often support smaller, emerging technologies, while, RPS policies promote larger and lower cost resources. PBC funds can also be used to help meet RPS goals (as CA is considering). • Efficiency: An EPS could conceivably provide efficiency targets, while an adjustable PBC could provide the means to achieve the targets.	

Residential/Commercial/Industrial Energy Efficiency (and Fuel Switching) Opportunities: Capturing these opportunities is the primary intent of PBC and EPS strategies. Specific residential options include for example efficient lighting, weatherization, heating/cooling systems upgrade and fuel switching, duct sealing, and water heating upgrade and fuel switching, and other equipment. Similarly a wide array of commercial sector options are available across lighting, HVAC systems, refrigeration, fuel switching, networked PC management, power supplies, and other equipment. Industrial sector opportunities exist, for example, with boilers, steam system, pumps, motors, compressed air systems. See Attachment 2.

Key Results:

Table 4. Summary of EPS/PBF Impacts

Implementation Level and/or Lead	WA state legislature, major electric utilities and other direct consumers	
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	1.2 (0.94 elec, 0.27 nat gas) 3.1 (2.49 elec, 0.65 nat gas) 27.0 (21.2 elec, 5.8 nat gas)
Net Direct Economic Savings ($million)	2010 2020	$41 $108
NPV Benefit ($million)	2005-2020	$555
Mitigation Cost-effectiveness ($/tCO2)	-$34 (negative cost)	
Key Ancillary Benefits and Costs	• reduced criteria air pollutants • reduced impacts of fossil fuel extraction	

These energy savings and GHG reductions could be implemented through an **EPS set at the following annual reductions per year from 2005 to 2020**.

- **0.86% for electricity**
- **0.53% for natural gas**

Alternatively these savings could be achieved through a **public benefits charge of**:

- **0.09 cents/kWh for electricity**
- **$0.001/therm for natural gas**

These estimates do not include added costs for administering these policies.

Data Sources, Methods, & Assumptions:
We estimated the total potential energy savings from efficiency programs based on the achievable potential as estimated by the Northwest Power Council for electricity (draft 5th power plan) and by Puget Sound Energy for natural gas (August 2003 Least Cost Plan). We scaled the energy savings to the Puget Sound 4-county region. We assumed the electricity reductions that the NW Power and Conservation Council estimated for 2025 could be achieved in 2020.[3] This adjustment was made because the Council's estimates may by conservative in the long run since a) the reductions are dominated by measures with lifetimes less than 15 years and b) the Power

[3] We also adjusted the Puget Sound Energy LCP estimates similarly, applying the 20-year savings (as % of projections without conservation) in 2020.

Council is limited to considering commercially available technologies (but future technologies may come into the market with greater savings potentials) and c) the Power Council considered energy savings that are cost-effective without any incentives for reducing GHG emissions.[4] [5]

Table 5. Gross PBF/EPS energy savings in 2020

	Electricity (aMW and % reduction from baseline)	Natural Gas (billion BTU % reduction from baseline)
Residential	327 (15%)	7,645 (10%)
Commercial	273 (14%)	6,497 (11%)
Industrial	60 (8%)	1,614 (5%)
Total	660 (15%)	15,756 (9%)

We then estimated the overlap in energy savings from appliance standards, building code upgrades and low GHG building design (see table in introduction) and determined the net energy savings. The net energy savings in 2020 – i.e. assuming other high priority strategies (BF3, BF6, BF8, and BF10) are also implemented -- are estimated as:

Table 6. Net PBF/EPS energy savings in 2020

	Electricity (aMW and % reduction from baseline)	Natural Gas (billion BTU % reduction from baseline)
Residential	275 (13%)	5,642 (7%)
Commercial	257 (14%)	5,004 (8%)
Industrial	60 (8%)	1,614 (5%)
Total	591 (13%)	12,261 (7%)

We estimated the direct economic savings by subtracting the average cost of saved energy (based on Power Council and Puget Sound Energy estimates) from the levelized avoided cost of electricity and natural gas as shown in Table 7. Avoided costs are based on Power Council estimates[6].

[4] To account for new technologies in the future, plus the added potential that would become available if avoided GHG emissions were valued more highly (e.g.$20/tCO2), the Oregon Governor's process added 20% to the Power Council's estimates (Draft document, Energy Efficiency Options for reducing GHG emissions, April 2004).
[5] Since we did not have further detail on implementation rates, we assumed linear growth in electricity savings from 2005 to 2020.
[6] Electricity costs from Aurora run labeled "02/20/04 Final", natural gas costs drawn roughly from *Revised Draft Fuel Price Forecasts for the Draft 5th Northwest Conservation and Electric Power Plan,* April 22, 2003, NW Power Planning Council Document 2003-7 rev.

Table 7. Comparative costs and savings of PBF/EPS programs

	"Costs"		"Savings"	
	Average costs of saved energy		Avoided cost of energy	
	Electricity (cents/kWh)	Natural Gas ($/MMBTU)	Electricity (cents/kWh)	Natural Gas ($/MMBTU)
Residential	2.8	$5.9	3.9	$7.1
Commercial	2.3	$2.9	3.9	$6.7
Industrial	1.7	$1.5	3.9	$6.0
Total	2.5	$4.8	3.9	

To determine the level of funding required for a Public Benefits Fund to achieve these levels of energy savings, we used information from Puget Sound Energy and Seattle City Light on the costs and energy reductions of their recent programs. They provided costs in terms of annual costs to utility to provide incentives or other means to encourage customers to conserve, divided by the estimated savings in the first year of the program. We applied these costs from 2005-2020, based on the additional energy savings in each year. This provided revenue requirements, which we then divided by energy consumption in each year to estimate the increase in rates required.

Table 8. Utility Costs of Acquiring Conservation

	Electricity (cents/kWh)	Natural Gas ($/MMBTU)
Program costs divided by first year energy savings	20	1.3

Emission reductions were calculated using marginal emission rate for electricity and the emission rate for natural gas. See attachments at the end.

BF7a. Residential Fuel Conversion Opportunities

Policy/Program Description: Direct use of natural gas for space and water heating in buildings reduces GHG emissions when compared with using natural gas to produce electricity then using transmitting the electricity large distance to buildings for heating. Many opportunities exist for fuel conversion; this program looks at one - converting residential electric water heaters to natural gas water heaters in homes that have natural gas space heating.

The Oregon Public Utilities Commission approved a similar concept in 1991 but implementation has not occurred due to concern that the program would provide incentives to households that would have switched anyway (free-riders). We have attempted to correct for this effect, but there is large uncertainty on the number of free-riders.

Key Results:

Table 9. Potential Residential Fuel Conversion Impacts

Implementation Level and/or Lead	**Municipalities, Utilities**	
GHG emissions reductions (Million Metric Tons CO2)	2010	0.02
	2020	0.05
	2005-2020	0.41
Net Direct Economic Savings ($million)	2010	Not estimated
	2020	Not estimated
NPV Benefit ($million)	2005-2020	Positive or zero
Mitigation Cost-effectiveness ($/tCO2)	Negative or zero	
Key Ancillary Benefits and Costs	• possible local increase in NOx emissions • possible overall reduction in criteria air pollutants	

Data Sources, Methods, & Assumptions:[7]
We estimated the number of natural gas customers currently using electric water heaters based on information from Puget Sound Energy (about 19% of customers). We assumed that about 16% of these customers would switch to natural gas without the program. We then assumed the program considered here would encourage half of the remaining customers to switch. These parameters combined with the assumed efficiency of natural gas water heaters (62%) and electric water heaters (92%) allowed us to estimate electricity savings of 26 aMW in 2020, countered by increased gas consumption of 11.5 million therms.

With the assumptions on the type of electricity that is most likely to be avoided from electricity conservation (see ES TWG Appendix), this program would lead to the emission reductions shown in Table 9.

Key Uncertainties
- Free-rider estimate (number of customers that would have switched to natural gas without the program
- Achievable penetration rates

[7] Thanks to Phil Carver, Oregon Department of Energy, and staff draft of report of Options to Reduce Carbon Dioxide for general information on this program in Oregon.

SUBGROUP B: Codes and Standards

Strategy: BF3. Appliance Efficiency Standards

Policy/Program Description: Appliance Efficiency Standards can be implemented at the state level for appliances not covered by federal standards. State appliance standards are among the strategies included in the September 2003 West Coast Governors' Global Warming agreement. The Codes and Standards Working Group formed by the Governors' Initiative has recommended in their April 2004 draft report that the states "adopt selected appliance energy efficiency standards for products not covered by the federal government." As they note, "minimum standards are the least-cost way for states to insure cost effective improvement of the energy efficiency of buildings and the equipment and appliances used in buildings."

Our analysis considers the costs and benefits of standards for most of the appliances listed in Table 12 below. California has already adopted standards for several of these products, and has standards currently under development for most of the others shown as well as others products not considered here, such as pool pumps.[8] Several other states are in the process of adopting many of these standards.[9]

WA CTED is currently drafting standards legislation to address most of the appliances shown in this list. Since they are contemplating the exclusion of the higher payback technologies (large packaged AC) and ceiling fans, we have excluded these from the analysis here as well. Puget Sound CPAC could provide input to and support for such legislation. Given that implementation would be statewide, we show the emissions and direct economic impacts both statewide and for Puget Sound in Table 10 below.

Key Results:

[8] Decisions on adoption of the additional CA standards are expected by December 2004.
[9] For more information on candidate appliances and the status of other state efforts, see www.standardsasap.org.

Table 10. Summary of Appliance Standard Impacts

Implementation Level and/or Lead	CTED, State Legislature		
		Puget Sound	**WA state**
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.15 0.30 3.00	0.29 0.59 5.90
Net Direct Economic Savings ($million)	2010 2020	$13 $29	$26 $56
NPV Benefit ($million)	2005-2020	$152	$295
Mitigation Cost-effectiveness ($/tCO2)	-$51		
Key Ancillary Benefits and Costs	• reduced criteria air pollutants • reduced impacts of fossil fuel extraction • reduced water consumption (200 million gallons by 2020)		

Data Sources, Methods, & Assumptions:
We adapted an analysis conducted by the American Council for Energy Efficient Economy (www.aceee.org). We used their estimates of appliance sales and incremental cost and savings per appliance (see Table 12) together with our common CPAC process parameters, such as discount rates and local avoided electricity and gas costs. The overall statewide results are shown below in Table 11. Puget Sound costs and savings according to the region's share of electricity and gas sales. *[Note that the Governors' process, NPPC and CTED are conducting similar analyses, which will review as they become available. We have also shared this analysis with the WA state lead on the WCG Codes and Standards WG.]*

Key Uncertainties
- The appliances under consideration.
- Interaction with codes and efficiency programs.
- Future changes in product design, preferences, and development

Ancillary Costs and Benefits:
- Water savings of over 200 million gallons/year by 2020 (in Puget Sound), 357 million gallons statewide (from spray valves and commercial washers)
- The *April 4 2003 WCG Codes and Standards WG report also several other benefits of codes and standards:*
  - "They drive down the market cost of energy efficiency improvements by building energy efficiency into the base model. Economies of scale cause energy efficiency improvements to be provided at dramatically lower cost than when the market only supplies the energy efficiency in premium models.
  - Energy efficiency is the least costly when built into the building or product at the outset. Trying to achieve the same efficiency later through retrofit is almost always much more expensive, if not impossible. Inefficiency is a particular burden on society for buildings and products that have long lives.

- Energy efficiency delivered through codes and standards is substantially less expensive than the cost of building an equivalent amount of new generation.

While voluntary incentive programs, such as those run by utilities, also deliver significant savings, codes and standards deliver savings at lower cost to society. Furthermore, public program resources are better spent on emerging measures and technologies rather than those that have been demonstrated to be ready for inclusion in codes and standards." (p.2)

Implementation Issues:

- o Washington currently has no appliance and equipment standards outside of building energy codes, nor is there any established efficiency certification and compliance-monitoring infrastructure. (per WCGWGI working group April report)

Table 11. Summary of Statewide Energy, Economic, and Water Benefits

WASHINGTON SUMMARY

	Commercial		Residential		Total	
Net Results	**2010**	**2020**	**2010**	**2020**	2010	2020
Electricity Savings (GWh)	**185**	**516**	**475**	**916**	660	1,432
Electricity Savings (aMW)	**21**	**59**	**54**	**105**	75	163
Gas Savings (Bill BTU)	**1,315**	**1,511**	**182**	**585**	1,497	2,096
Water Savings (Mill Gallons)	178	317	36	40	214	357
Net Benefit ($million)					$26	$56
NPV million (to 2020, $million)						$295

Table 12. Assumptions for appliances analyzed (from ACEEE, personal communication)

ACEEE Standards Analysis, Key Input Assumptions 5/7/04

Products	National Annual sales (2001) (million)	Current Standard or Baseline	New Standard or Average Use	Unit	Basis for New Standard	Effective Date (Year)	Average Product Life (Years)	Annual Baseline Use per Unit	Annual Savings Per unit	Unit	Per unit Incremental Cost ($)
Beverage merchandisers - Tier 1	0.14	4438	4077	kWh	CEC 2004	2006	8.5	4438	361	kWh	19
Beverage merchandisers - Tier 2	0.04	4077	2711	kWh	30% below CEC 2004	2006	8.5	4077	1366	kWh	71
Ceiling fans (with lights)	13.05	Incand.	CFL		E* lamps	2007	13	213	132	kWh	6
Comm'l clothes washers	0.27	0.82	1.26	MEF	Same as Resid. +WF	2006	8	see below breakdown			137
electricity	*0.04*					*2006*	*8*	*564*	*197*	*kWh*	
natural gas	*0.04*					*2006*	*8*	*94*	*33*	*therm*	
water	*0.04*					*2006*	*8*	*54203*	*9849*	*gallons*	
Comm'l packaged A/C (over 20 tons) - Tier 1	0.04	8.5	10	EER	CEE Tier 2	2006	15	67468	10120	kWh	1,260
Comm'l packaged A/C (over 20 tons) - Tier 2	0.04	10	10.5	EER	CEC proposed 2nd tier	2010	15	57348	2731	kWh	924
Comm'l refrigerators & freezers - Tier 1	0.23	4651	4111	kWh	CEC 2004	2006	9	4651	540	kWh	29
Comm'l refrigerators & freezers - Tier 2	22.00	4111	3416	kWh	Energy Star & CEE T1	2006	9	4111	694	kWh	37
Dehumidifiers - Tier 1	0.99	972	816	kWh	Energy Star	2006	15	972	156	kWh	1
Dehumidifiers - Tier 2	0.99	816	735	kWh	Revised Energy Star	2006	15	816	82	kWh	1
Dry type transformers	22.00	76	59	kWh	TP-1	2005	30	76	17	kWh	3
Exit signs	1.35	28.5	3	Watt	E-Star (LED)	2005	25	250	223	kWh	20
External power supplies	203.0	39.4	30.5	kWh	Ecos proposal, tier 1	2006	7	39	9	kWh	0.54
Ice-makers	0.23	3746	3327	kWh	CEE Tier 1	2007	8.5	3,746	419	kWh	30
Metal halide lamp fixtures	2.93	460	390	Watts	Pulse start ballast	2007	20	2,015	307	kWh	30
Digital cable and satellite TV boxes	9.10	20	15	Watt	Energy Star Tier 1	2006	5	182	50	kWh	5
Digital TV converter boxes	9.20	6	3	Watt	Energy Star Tier 1	2006	7	53	26	kWh	5
Pre-rinse spray valves	0.35	3.15	1.8	gpm	Based on pro. to CEC	2006	5	see below breakdown			5
natural gas	*0.35*	*1,566*	*1170*	*therms*	*Energy Star Tier 1*	*2006*	*5*	*1,566*	*396*	*therms*	
water	*0.35*	*3.15*	*1.8*	*gpm*	*Based on pro. to CEC*	*2006*	*5*	*4574*	*1157*	*gallons*	
Torchiere lamps	12.20	344	75	Watt	<190W (mostly CFL)	2005	10	414	288	kWh	20
Traffic signals	0.54	108.5	10	Watt	E-Star (LED)	2005	10	475	431	kWh	85
Unit heaters (nat. gas)	0.23	67%	80%	Seas. Eff.	Power draft	2006	19	1,644	267	therm	277
Vending machines - Tier 1	0.25	4449	4047	kWh	Lighting only, in 20% of s	2006	10	4,449	402	kWh	25
Vending machines - Tier 2		4047	2891	kWh	Draft Energy Star spec	2006	10	4,047	1,156	kWh	75

Strategy: BF6. Building Code Changes, Training, and Enforcement

Policy/Program Description: Improving state building codes is one of the strategic elements of the West Coast Governors' Global Warming Initiative. It shares many of the benefits described above for appliance standards: cost savings to consumers, economies of scale for builders and suppliers, and avoiding "lost opportunities" for these savings once buildings are constructed.

This strategy could encompass at least two linked efforts:

> **a) Training of Building Officials and Improved Code Enforcement**. The capacity of building officials to implement and enforce is essential to reaping the energy and costs savings implicit in any building code. Together these would help increase the rate of code compliance and could also offer opportunities to encourage designs that exceed code requirements, and achieve the benefits described below for low-GHG buildings. These efforts are instrumental in achieving the emissions reductions implied in current or upgraded codes (per below), it is difficult to quantify the energy savings that would accrue directly from training and enforcement activities.
>
> **b) Upgrades to Existing Building Codes.** There are two paths to improved codes: upgrading the current state building code and/or municipalities' adoption of commercial building codes stricter than the state code (not allowed for residential codes). For example, Seattle has a commercial code that includes measures beyond state code, and it has been suggested that these upgrades yield about a 10% reduction in building energy use relative to the state standard.
>
> On the state level, a package of changes in the state commercial code was proposed last year, but rejected by Washington State Building Code Council in November 2003.[10] The Governor has also recently requested reconsideration of the code package, and the Code Council is revisiting their deliberations, with a decision expected no later by November 2004. The Council conducts a public process to review and adopt code modifications. The adopted package of amendments is presented to the legislature. If the legislature does not reject the code amendments, they are codified.

[10] In early 2002, the residential energy code upgrade was approved. Principal energy savings were in homes heated with natural gas, propane and heat pumps.

Key Results:

Table 13. Summary of Building Code Impacts (Code Upgrade)

Implementation Level and/or Lead	**State Building Code Council and/or Regional Municipalities**	
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.046 0.183 1.288
Net Direct Economic Savings ($million)	2010 2020	Not yet estimated (likely to be positive)
NPV Benefit ($million)	2005-2020	
Mitigation Cost-effectiveness ($/tCO2)	(likely to be "negative")	
Key Ancillary Benefits and Costs	• Similar to other energy efficiency measures	

Data Sources, Methods, & Assumptions:
WA CTED commissioned an analysis of commercial building code improvements. This analysis, prepared by Ecotope, estimated the first year energy savings from the proposed changes to the Washington State commercial building code (2003/2004 proposed changes). The savings shown above are based on the Ecotope values (1.47 aMW electricity and 138,000 therms natural gas) but adjusted to reflect savings in Puget Sound and savings over time. Tellus estimates for Puget Sound are 0.64 aMW of electricity and 61,938 therms of natural gas in first year increasing to 7.65 aMW and 719,000 therms in 2020 (assuming codes are implemented by 2008). These energy savings and the resulting GHG reductions reported in Table 13 are relatively small since they only reflect the savings based on the current proposed amendments. Further reductions could be possible over time if the building code was designed to encompass more energy efficiency features and if the code was continually upgraded to account for new and emerging building practices and technology improvements.

Key Uncertainties: Future changes to the building code and resulting energy and GHG reductions

Ancillary Costs and Benefits: Similar to appliance standards above.

Implementation Issues: Electric utilities would lose load, while gas utilities gain them (not an issue in the PSE electric territory).

SUBGROUP C: Tax and Other Incentives

BF4. Tax and Other Incentives for Efficient Buildings and Equipment

Policy/Program Description: Tax incentives, discounts or rebates can be used to promote adoption of Energy Star, CEE Tier 2, or otherwise rated devices. These policies have been used to increase market shares for advanced technologies and practices through incentives, visibility and validation of products' credibility. Increases in market share can induce more firms to enter market, leading to price reductions and, at some point, cost-competitiveness of the product without tax credit or incentive. Hawaii, Idaho, Maryland, Massachusetts, New Jersey, New York and Oregon offer tax incentives for energy efficiency. For example, Idaho offers income tax deductions to residents that install measures such as insulation, storm doors, caulking, and weather-stripping. Oregon offers a variety of tax incentives for green buildings, businesses and residents (see http://www.energy.state.or.us/res/tax/2003.pdf, http://www.energy.state.or.us/bus/tax/Cons.pdf, http://www.energy.state.or.us/bus/tax/Sustain.pdf)

TWG may wish to decide on which specific tax incentives to recommend. The following reflects input from Gary Smith, IBA:

There are generally two primary types of tax incentives:

- *Tax incentives to make capital purchasing decisions. Examples of such tax incentives are the sales tax exemption for the purchase of manufacturing and research and development equipment. This tax incentive is seen as very important in Washington State to encourage manufacturers and research firms to locate in Washington State and produce jobs in Washington State.*
- *Tax incentives to encourage an on-going change in behavior. I most states, this is done through tax deductions and tax credits against a state income tax. Since Washington State does not have an income tax, reductions or exemptions are provided for certain on-going activities using other taxes. For example, RCW 82.16.055 provides a deduction from gross operating income subject to public utility tax is allowed for the cost of producing energy through: (1) cogeneration facilities as defined in RCW 82.35.020, or (2) renewable energy resources such as solar energy, wind, hydroelectric, wood, and agricultural products.*

The most effective tax incentives, and the most challenging to get enacted, is generally the sales tax reduction or exemption for capital purchases given that the state and local sales tax rate in many parts of the state exceeds 8% of the purchase price. This is a tax incentive that usually has the greatest monetary value to the purchaser, it is of significant enough size to impact the purchaser's buying decision, it is immediate at the time of purchase and it is immediate rather than incremental over time. On-going tax incentives are also beneficial but generally have less impact on purchasing decisions.

For Climate Protection, the Advisory Council should consider both types of tax incentives (exemptions) and possibly combinations. For example (the following are for demonstration purposes as the author is not advocating these for adoption):

- *To encourage people to build buildings using a low GHG design, sales tax reductions or exemptions may be considered for buildings that meet a certain set of criteria.*
- *To encourage people to improve heating efficiency, the Committee may want to consider a utility tax reduction for a residential or commercial customer who meets a certain set of maintenance*

and operation requirements. Or, a lower utility tax for facilities that use less than x units of electricity or natural gas per square foot, and a higher utility tax for facilities that use more than z units of electricity of natural gas per square foot.

Data Sources, Methods, & Assumptions:
See also: *Tax incentives for Energy Efficiency and Green Buildings: Opportunities for State Action*. Elizabeth Brown, Patrick Quinlan, Harvey Sachs and Daniel Williams. March 2002.

Ancillary Costs and Benefits:

Implementation Issues:

Strategy: BF8. Incentives for Low GHG Design in New Residential Construction

Policy/Program Description: Various programs promote "green building" designs, such as Energy Star Homes, the Master Builders' BuiltGreen, and the USDOE Building America program. Various incentives can be provided by utilities, municipalities, and state agencies ranging from design assistance, permitting assistance, and financial incentives.

David Goldberg's memo noted the following:

- Mortgage/Lending Strategies – Larger loans and mortgages made available for low energy use buildings, as less income is needed for monthly utility bills. Lower energy use = potential reduced risk for lender.
- Sliding scale building permit fees with reduced fees for high energy performance buildings.
- Expedited permitting for high energy performance buildings.
- Building commissioning requirements for occupancy permits.
- Keep raising the bar on energy efficient appliances – a large percentage are already on the Energy Star list.

Key Results:

Table 14. Potential Low-GHG Residential Building Design Impacts

Implementation Level and/or Lead	**Municipalities, Utilities**	
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.11 0.45 3.15
Net Direct Economic Savings ($million)	2010 2020	Not calculated Not calculated
NPV Benefit ($million)	2005-2020	Not calculated
Mitigation Cost-effectiveness ($/tCO2)	Low / Medium ($3 for the one example below)	
Key Ancillary Benefits and Costs	? Same as above for energy efficiency measures ? occupant health, water conservation, waste management benefits often bundled in ""green"" buildings"	

Data Sources, Methods, & Assumptions:
The USDOE Building America program for new residential construction sets a high standard – 50% energy efficiency improvement compared to 95 Model Energy Code (national) (this is equivalent to a Home Energy Rating System (HERS) score of 90). Mithun (David Goldberg) has also provided an assessment of the costs and energy savings for a housing project in Portland Oregon to achieve this level of efficiency.

We estimate potential regional energy savings by assuming an overall energy savings of 10% for new buildings, starting in 2008. These reductions could be achieved by obtaining the USDOE Building America target level efficiency improvement (50%) and an (ambitious) penetration rate of 20% of new houses, starting in 2008. Or similar energy savings could be reached through a lower penetration of buildings starting at an earlier date or by lower energy savings in a higher number of households.[11]

To roughly estimate the cost-effectiveness of building to this standard, we used the data provided by Mithun, specifically:

- Construction cost increase — $3,913/unit
- Electricity savings (per unit) — 9,677 kWh/year

To estimate annual costs, we annualized the construction cost increase at $391 per year, and estimated avoided electricity costs at 3.91 cents/kWh (from NW Power and Conservation Council avoided costs). The annual avoided electricity cost is $0.0391 * 9,677 = $379. The difference ($391-$379) provides the net benefit per unit of $12 per year. GHG emission reductions are estimated using an emission factor of 0.447 metric tons CO2/MWh, so annual

[11] As a check on the realistic penetration rate, we contacted representatives at the Home Builders Association of Kitsap County. They have run a BuiltGreen program since 1997 and have over 1000 buildings registered. This program looks at aspects beyond energy efficiency and they did not have estimates of energy savings. However, 1000 buildings represent about 10% of the number of new buildings in Kitsap County (Tellus calculation based on Census numbers). We used 20% penetration as an estimate of the impact of a particularly well-funded and focused program.

reductions are 4.33 metric tons. So a rough calculation of cost effectiveness is $12/4.33 or about $3 per ton reduced.
We conservatively categorize this as Low/Medium ($0-50/tCO2) since costs will vary by site – with housing projects likely providing a lower cost opportunity than dispersed suburban houses – and natural gas benefits per unit could be lower.

Key Uncertainties

- Variation in costs among housing types
- Target energy performance levels
- Achievable penetration rates

Ancillary Costs and Benefits:

- occupant health, water conservation, waste management benefits often bundled in "green" buildings
- Potential non-energy GHG savings, e.g. from material selection (wood, cement, steel)
- Effects of varying/influencing total square footage

Implementation Issues:

Strategy: BF10. Incentives for Low GHG Design in New Commercial Construction

Policy/Program Description: Various programs have been developed to provide incentives for Green Building designs, such as Master Builders BuiltGreen and City of Seattle's Sustainable Buildings Program[12]. Some states offer green building tax credits (NY, MD, OR) for buildings meeting LEED or other standards.

Several members of the working group indicated a preference for using LEED certification, as a recognized and established system. For natural gas savings, we used the LEED silver level for this analysis and assumed that 40% of new buildings could achieve this level, starting in 2008 (similar energy savings could be reached through a lower penetration of buildings starting at an earlier date). Estimates of energy savings and costs were taken from *The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building task force (Greg Kats, Capital E, 2003).* For electricity savings, we used estimates from the NPCC 5th plan analysis.

Key Results:

[12] The City of Seattle's Sustainable Building Policy is an integral part of the City's move toward sustainability, calling for new City-funded projects and renovations with over 5000ft^2 of occupied space to achieve a Silver Rating using the US Green Building Council's (USGBC) LEED Rating System™.

Table 15. Potential Low-GHG Commercial Building Design Impacts

Implementation Level and/or Lead	**Municipalities, Utilities**	
GHG emissions reductions (Million Metric Tons CO2)	2010	0.10
	2020	0.40
	2005-2020	2.79
Net Direct Economic Savings ($million)	2010	-4
	2020	25
NPV Benefit ($million)	2005-2020	50
Mitigation Cost-effectiveness ($/tCO2)	Negative (-$28)	
Key Ancillary Benefits and Costs	? Same as above for energy efficiency measures ? occupant health, water conservation, waste management benefits often bundled in ""green"" buildings"	

Data Sources, Methods, & Assumptions:
For electricity savings, we used the conservation estimates from the Northwest Power and Conservation Council plan's 5th plan. The plan estimates energy savings from "Integrated Building Design" and we converted the savings for the region to estimates for Puget Sound. This results in annual savings in 2020 of about 52 aMW (we assumed that a well-funded, focused program could achieve the conservation savings that the NPCC estimated for 2025 by 2020).

For natural gas savings and overall costs, we relied on the Kats study estimates of 30% energy reductions for LEED silver with a 2% cost premium (construction and design). These values represent that cost and energy savings from 16 LEED Silver buildings around the country, including the Municipal Courts in Seattle (4% cost premium) and Clackamas High School in Oregon (0.3% cost premium). Using an average construction cost of $200/Square foot (Kats study, representing costs in California), the additional cost for LEED silver is $4.2 / Square foot (these are higher than the New Buildings estimates of $1-$2/square foot).

Key Uncertainties
- Target energy performance levels
- Variation in costs among building types
- Achievable penetration rates
- Accounting for municipal buildings already targeted

Ancillary Costs and Benefits:
- occupant health (such as positive impacts of increased daylighting), water conservation, waste management benefits often bundled in "green" buildings
- Potential non-energy GHG savings, e.g. from material selection (wood, cement, steel)
- Effects of varying/influencing total square footage

Implementation Issues:

SUBGROUP D: Training and Education

Strategy: BF12. Training of Commercial Building Operators

Policy/Program Description: provides another tool to reduce fuel and electricity use in existing buildings. The Northwest Energy Efficiency Alliance has developed a program from Building Operators Certification in energy management. The alliance has shown high success of this program. Puget Sound communities could, for example, require or request that all operators of buildings over a certain size obtain this certification.

Not Analyzed Further. **See also:** Evaluation of NW alliance building operator certification: http://www.nwalliance.org/resources/reports/88.pdf

Strategy: BF16. Industrial Energy Management Training

Policy/Program Description: and related activities would aim to capture energy savings and emissions reductions from improved O&M of existing equipment.

Not Analyzed Further. **See also:** CIPEC guide http://oee.nrcan.gc.ca/publications/infosource/pub/cipec/Managementguide_E.pdf

SUBGROUP E: Specialized strategies

Strategy: BF5. HFC Reduction Opportunities

Policy/Program Description: HFC reduction opportunities should be explored, given this rapidly growing emissions source. The preliminary baseline that GHG emissions from HFCs are expected to grow from 1% of Puget Sound GHG emissions in 2000 to nearly 5% by 2020. Most HFC emissions result from leaks in mobile air conditioning and refrigeration applications. Industry sources have claimed large reductions in leakage rates from mobile air conditioners, but the overall impact of these reductions may be lower than the claims indicate due to leakage during accidents and vehicle repairs and due to the trend of increased penetration of air conditioning in new vehicles.

One policy option would be to encourage the substitution hydrocarbon refrigerants (HCs - propane or isobutene/propane blend) for recharging HFC or old CFC systems. Auto industries have cited safety concerns about HC systems, and several studies are addressing these concerns.

Use of hydrocarbon or carbon dioxide refrigerants have shown promise for reducing HFCs from refrigeration and mobile air-conditioning in studies in Europe and US.

Not Analyzed Further. **See also:** US EPA 2001. *U.S. High GWP Gas Emissions 1990–2010: Inventories, Projections, and Opportunities for Reductions* June 2001. EPA 000-F-97-000. "Although the cost of replacing HFCs with carbon dioxide in motor vehicle applications is greater than \$200/TCE and is not studied further, it is important to note that this option represents a potentially significant reduction opportunity. Furthermore, carbon dioxide in motor vehicle applications may provide other benefits such as improved comfort. This analysis suggests that, by 2010, this application would eliminate 17 MMTCE, equivalent to 44 percent of the total HFC emissions from the refrigeration and airconditioning sector." Note that \$200/TCE is equivalent to about \$50/metric ton of carbon dioxide.

Anderson, Jason. 2003. *Keeping cool without warming the planet: Cutting HFCs, PFCs and SF6 in Europe.* Climate Network Europe. http://www.climnet.org/pubs/PIGGfinal.pdf
The research in Europe indicates that hydrocarbon refrigerants are "cheaper and often more efficient and effective" than HFCs.

Strategy: BF11. Recommissioning of Commercial Buildings

Policy/Program Description: Recommissioning is a management tool for identifying system operating, control, and maintenance problems in existing buildings. Basically, it seeks to ensure that buildings are operating to their designed performance, or better if practices have improved since the buildings were built. Energy and water consumption are usually a large component of building performance. Note that commissioning often refers to performance of new buildings while recommissioning refers to performance of existing buildings.

Key Results: ***note these savings are already included under the eps/pbf estimates (table 4).***

Table 16. Potential Commercial Building Recommissioning Impacts

Implementation Level and/or Lead	**Municipalities, Utilities**	
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.068 0.182 1.54
Net Direct Economic Savings (\$million)	2010 2020	Not estimated Not estimated
NPV Benefit (\$million)	2005-2020	Positive (cost effective measure)
Mitigation Cost-effectiveness (\$/tCO2)	Negative	
Key Ancillary Benefits and Costs		

Data Sources, Methods, & Assumptions:
The NPCC 5th plan analysis of conservation potential includes recommissiong measures designed to optimize the operation of HVAC systems. The NPCC estimates are based primarily on analysis completed by the NW Alliance (see for example http://www.nwalliance.org/resources/reports/124.pdf).

We adjusted the NPCC's regional analysis, to estimate potential savings in Puget Sound of 43 aMW in 2020. These savings have been included under the PBF/EPS savings in table 4 above and should not be double-counted.

Savings in natural gas consumption may also be possible with this measure but have not been estimated here.

NPCC estimated an overall cost of 3.6 cents/kWh, slightly lower than the avoided cost estimates (see table 7). Thus this measure would yield net economic benefits.

Strategy: BF13. Efficiency Improvements at Water and Wastewater Treatment Plants

Policy/Program Description: involve process controls and pumps to reduce energy use and can be implemented by government agencies

Not Analyzed Further. **See also:** Northwest Alliance has a project to help development of BacGen, http://www.nwalliance.org/resources/documents/BacGenBrochure.pdf. Northwest Power Planning and Conservation council also includes savings from water and wastewater measures in its conservation plan.

Strategy: BF15. Various Emission Reduction Opportunities in Cement Production and Use

Policy/Program Description[13]: Cement production and use are emissions-intensive activities. For each ton of cement produced, approximately one ton of CO_2 emissions are created. About half of these emissions are the result of energy used to make cement, the other half are due to the CO_2 released when raw materials are "calcined" in the cement manufacturing process (when calcium carbonate in limestone and other materials is heated and converted to calcium oxide, releasing carbon dioxide). In 2002, two Puget Sound manufacturers, Ashgrove and Lafarge, produced about 1 million tons of cement, and thus about 1 million tons of CO_2. Because of its weight, cement is typically produced locally and transported no more than 250 to 500 miles. Thus much of the region's cement production is likely consumed within Puget Sound, and vice versa.

There are three general strategies to reducing CO_2 emissions, as outlined by the Portland Cement Association:

1. Manufacturing Process — Reduced emissions through increased efficiency, decreased fossil fuel use, and greater use of alternative fuels and recycled materials;
2. Product Formulation — Cement composition incorporating a lower proportion of calcined materials, thereby reducing carbon dioxide emissions per unit of product; and,
3. Product Application — Development and promotion of concrete products that provide sustainable solutions for the building, design and construction industry.[14]

One of the more successful strategies is the increased use of additives such as fly ash to substitute for the calcined materials (or clinker) in cement. Increasing the fraction of additives leads to longer curing times for so-called "blended cements", and thus some barriers in the construction industrial, but ultimately yields a product with greater strength. Up to 50% substitution can be achieved, thus effectively reducing overall CO_2 emissions roughly in half, the Environmental Learning Center on Bainbridge Island being a prominent example. On average the current fraction of additives is only around 5-10%. Furthermore, much of the cement used in the region goes into major capital projects (stadiums, wastewater facilities, etc.) and roads. These applications represent major new possibilities for decreasing the clinker fraction in cement used.

However, there are at least two key constraints:

- The use of fly ash as a cement additive has proven quite popular, and supplies of high quality ash from the Centralia coal plant are currently limited.
- While significant advances have been made opening up the market for blended cements in building applications (blended cements are also less expensive), and adapting to the longer setting times, there has been less experience with roads and major capital projects. The use of blended cements is currently being considered for the Brightwater project.

The CPAC could consider initiatives such as demonstration projects to support these efforts,

- Promoting the use of blended cements in state and local construction projects.

---

[13] Chris Dixon of Mithun provided invaluable inputs on cement use issues in the region.

[14] http://concreteproducts.com/mag/concrete_pca_proposes_revised/

- Establishing the use of blended cements in large capital projects and road construction through pilot and demonstration projects
- Developing alternative sources of cement additives of acceptable quality (e.g. for lower quality ashes) through research and other support activities.
- Working with local cement manufacturers to explore these and other opportunities (e.g. the use of lower-carbon fuels in cement manufacture)
- Support the development of local codes and crediting for the use of lower-CO2 cements. (Currently LEED provides limited credits for blended cements).

Key Results:

Table 17. Potential Cement Use Impacts

Implementation Level and/or Lead	**Local and state agencies**	
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.05 0.09 0.84
Net Direct Economic Savings ($million)	2010 2020	Not estimated Not estimated
NPV Benefit ($million)	2005-2020	Not estimated
Mitigation Cost-effectiveness ($/tCO2)	Negative to Low	
Key Ancillary Benefits and Costs	Reduced local air emissions from cement manufacturing facilities	

Data Sources, Methods, & Assumptions:

Lacking a detailed assessment of cement production and use opportunities, we considered only the potential emissions savings from blended cement, and made the following simple calculation:

1. Estimate the amount of emissions from producing cement used in the region, both from calcinations and energy use at cement plants. To first order, we assume that the amount used in the region is roughly equal to the average amount produced in the region, which we assume stays at approximately 1 million tons of cement per year through 2020.[15] We then apply a standard emission factor of about 1 short ton CO2 per ton of clinker produced (energy use and calcinations) based on US averages.[16] The result is an estimated 0.93 MMTCO2 of emissions per year (converting to metric units).
2. Assume the achievable reduction in clinker used, on average, in cements used in the region. We assume that a 5% reduction is achievable by 2010 and 10% reduction by 2020, a reduction level roughly in line with the cement industry's commitment to reduce carbon dioxide emissions per ton of product by 10 percent between 1990 and 2020.[17]
3. Calculate GHG emissions reductions as the % reduction times the emissions above.

[15] The 2000-2002 average was 1.07 million tons, down from previous years. Increased economic activity might be expected to increase this number in the future, however the baseline forecast assumes flat cement-related emissions.
[16] See e.g. http://www.nescaum.org/Greenhouse/Private/PGE_Coal_Ash_Case_Study_Final_4-26-02.doc
[17] http://concreteproducts.com/mag/concrete_pca_proposes_revised/

Estimating costs is more difficult. Typically, reducing the clinker content reduces the cost of cement, saving material costs. However, overcoming barriers to using blended cements requires pilot programs and educational efforts, as well as potential changes in construction practices to accommodate longer setting times. GHG offset projects based on blended cement have sold credits at less than \$2/tCO2.

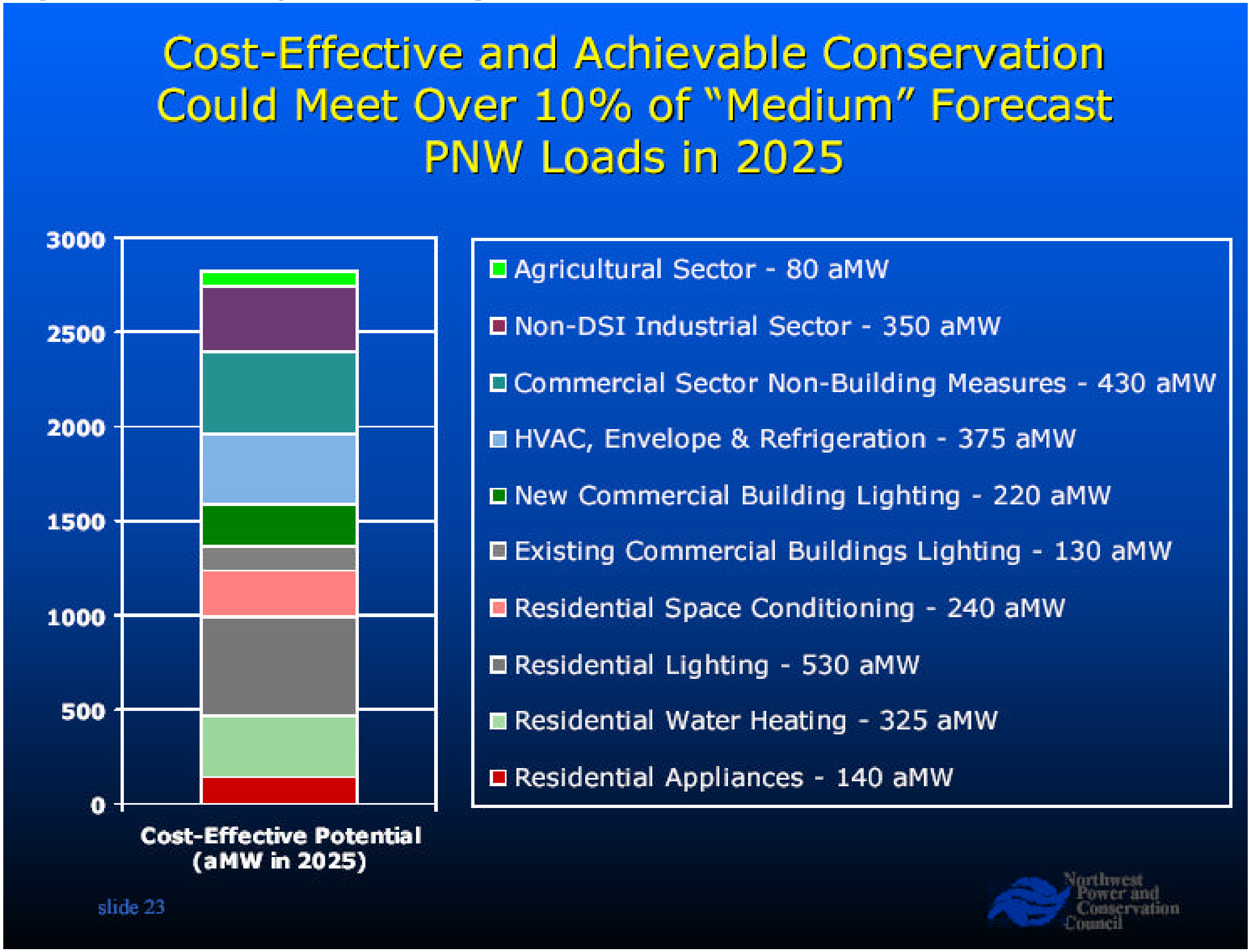
Ancillary Costs and Benefits:

Implementation Issues: See above.

ATTACHMENT 1: Common parameters and assumptions

Common Parameters		
Earliest Start Date	**2005**	
Cost Reference Yr	**2002**	
Cost-Benefit Parameters		
Real Discount Rate	**5.00%**	
Levelized Avoided Costs - Electricity		
Avoided Electricity (busbar)	**$36.4**	$/MWh
Avoided Electricity (delivered)	**$39.1**	$/MWh
Bulk Power T&D Credit	**$3.0**	($/kw-yr)
Local Power T&D Credit	**$23.0**	($/kw-yr)
Bulk Power T&D Loss Factor	**2.5%**	
Local Power T&D Loss Factor	**5.0%**	
Combined T&D Loss Factor	**7.5%**	
Levelized Avoided Costs - Natural Gas		
Levelized Avoided Utility Gas Price	**$3.8**	$/MMBtu
Avoided Residential Gas Costs	**$7.1**	$/MMBtu
Avoided Commercial Gas Costs	**$6.7**	$/MMBtu
Avoided Industrial Gas Costs	**$6.0**	$/MMBtu
Avoided Water Supply Costs	**$2.0**	$/100cf
Avoided Water Supply Costs	0.0027	$/gal
Puget Sound Fractions of WA State Energy (2000)		
Elec		
Residential	**47%**	
Commercial	**55%**	
Industrial		
Gas		
Residential	**65%**	
Commercial	**61%**	
Industrial		

Attachment 2: Projected conservation opportunities in the Pacific Northwest (NPPC)
(http://www.nwcouncil.org/news/2004_04/3.pdf)

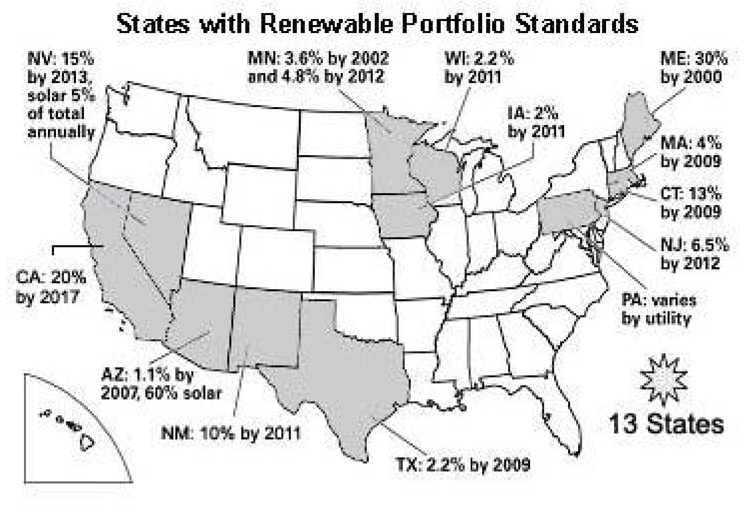


Appendix J: Energy Supply Strategy Analyses

This appendix represents the results of the supporting technical analysis, as guided by the Energy Supply Technical Working Group.

Strategy: ES1. Renewable Portfolio Standards (RPS)

Policy/Program Description: Renewables Portfolio Standards (RPS) require that a certain percentage of a utility's electricity sales be derived from renewable resources. RPS policies are currently in place in about 13 states, one city (Fort Collins, CO) and a single utility, JEA, in Florida).



Source: Union of Concerned Scientists

An RPS was included in Washington legislative proposal HB2333 this year, which did not pass out of committee. This legislation specified that larger utilities (>25,000 meters and >7 customers/mile of line), direct service, and market customers would need to provide 5% retail sales by 2010, 10% by 2015, and 15% by 2023 from eligible renewables. The legislation also enabled tradable renewable energy credits (a flexibility mechanism) and a cost cap. Eligible resources would include wind, solar, geothermal, biomass, landfill gas, sewage gas, and hydro upgrades (no new water diversion) or irrigation canal additions. Targets are aimed at "new" renewable, i.e. those added since 1999.

The Puget Sound CPAC could support RPS legislation at the state level. It could also support implementation of RPS targets at an individual utility level.

Key Results: One of the key uncertainties related to the impacts of a renewable portfolio standard is the fate of the federal production tax (PTC) credit for renewable energy.[1] Therefore,

[1] The PTC has until recently provided a credit of approximately 1.8 cents/kW/h over the first 10 years of operation for new wind, closed-loop biomass, and poultry waste facilities. The PTC was suspended when Congress failed to reauthorize it last year. Most analysts expect reauthorization when the energy legislation deadlock is broken or is sidestepped through separate legislation. Some proposals to reauthorize the PTC would extend the tax credit to geothermal and solar applications at the standard rate (1.8 c/kWh) and to open-loop biomass, landfill gas, and municipal solid waste applications at a reduced rate (1.2 c/kWh).

we analyze three scenarios: a) PTC continuation through 2020; b) PTC continuation through 2010; c) no PTC.

The results table below shows the different cost impacts of three PTC cases. The emissions reductions shown are the same for each case, since we use the same marginal emissions factor. Further (integrated modeling) analysis would be needed to clearly distinguish the full impacts of all three cases, since, absent the PTC more coal and gas resources are likely to enter the baseline, and the impacts of the RPS would be much more pronounced (in costs and in associated emissions reductions). With PTC in place, the RPS goals might even be met under expected market conditions. The Council runs shown in Table 8, Table 9, and Table 10, which assume PTC continuation, show wind increasing to 7-10% of the regional mix by 2020, suggesting the goals of the RPS might be achieved under reference case conditions. Under this situation an RPS could serve to ensure these goals are met or could set a higher standard (e.g. by going beyond the HB2333 requirements).

It is important to note that should all of the electricity demand reductions for the Buildings and Facilities (and CHP) options be achieved, the autonomous penetration of renewables is likely to be far lower than indicated in the Council reference case runs, simply because the need for new capacity is dramatically reduced. Under this situation, an RPS or similar policy might be needed to achieve substantial growth in renewables. An RPS might then create or deepen surplus capacity conditions, and utilities might increase net exports or sell other generation assets.

Table 1. Impacts of Renewable Portfolio Standard

Implementation Level and/or Lead	**State legislation or individual utilities**			
Production Tax Credit Scenario		**PTC to 2020**	**PTC to 2010**	**no PTC**
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.61 1.87 15.52		
Net Direct Economic Costs ($million)	2010 2020	$1.1 $33	-$1.0 -$19	-$16 -$33
NPV Cost ($million)	2005-2020	-$72	$77	$171
Mitigation Cost-effectiveness ($/tCO2)		-$5 Negative	$5 Low/Med	$11 Medium
Levelized (2006-2020) Bill Cost (c/kWh)		-0.02 c	0.02 c	0.05 c
Key Ancillary Benefits and Costs	Local economic development and spillover effects, reduced criteria air pollutant emissions (if renewables development is nearby)			

Figure 1. Annual costs and benefits of an RPS

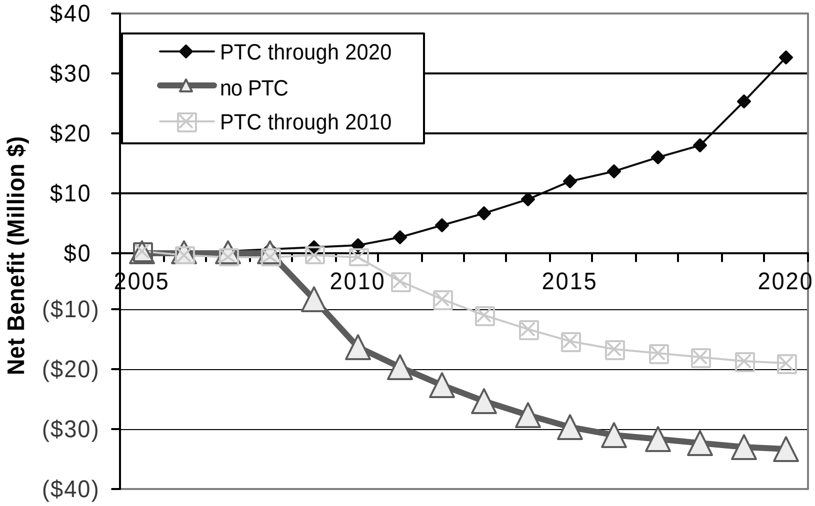
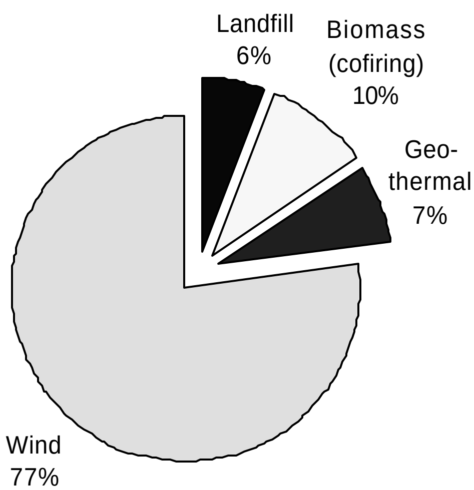
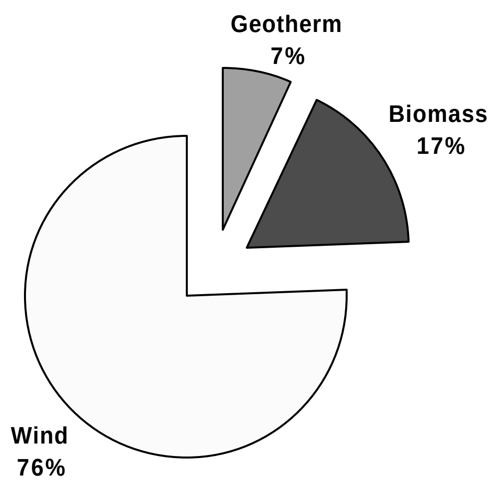


Figure 2. Two estimates of new renewables acquired under an RPS by 2020, by % of generation: Spreadsheet analysis on left, recent 5/13/04 NEMS run on right





Data Sources, Methods, & Assumptions:

We examined the RPS using a spreadsheet approach. We first estimated the renewables acquired by Puget Sound entities based on projected regional loads, current utility renewables portfolios, and specifications of the HB 2333 legislation. We then calculated the incremental cost of these renewable resources relative to projected avoided costs (around $36/MWh), and estimated avoided emissions using the marginal emissions rate (0.48 tCO2/MWh, see Attachment 4).

Key assumptions and uncertainties:

- **Avoided emissions reductions (as noted above).**
- **Fate of the Production Tax Credit (as noted above)**.
- **Future costs of renewables**. See Attachment 1 for cost assumptions used.

- **Shaping and ancillary costs.** Due to its intermittency, wind electricity imposes additional costs in terms of backup power and transmission services. We assume that these so-called "shaping ancillary services" cost 0.6 cents/kWh through 2010, based on analysis by Hirst and Pacificorp.[2] After this time, we use NEMS data (on wind capacity credit and backup power needs) to reflect potential increases in costs as wind penetration rises.
- **Avoided electricity costs.** For the simple cost-benefit analysis, we use a levelized cost of $36.4/MWh for marginal electricity based on modeling runs (02/20/04 Final) by Council for its 5th Power Plan analysis. For the NEMS runs, key assumptions are shown in the Attachment
- **RPS design, REC markets, and integration with other regions**: States have considered and adopted a variety of RPS targets and designs. Some of key design parameters include target level, treatment of new vs. existing renewables, cost caps, flexibility mechanisms (e.g. banking and borrowing to meet targets), and compliance methods. Integration with other states' RPS can simplify administration and tracking. At the same time, the more that states go after the renewable resource, increasing the pressure on the region's resources as well as helping to bring down costs as the result of technology innovation and learning-by-doing. All of these factors will affect the overall outcome.
- **Renewable resource potentials.** It is unlikely that a 15% RPS by 2023 would exhaust low-cost wind and other renewable sites (based on various resource studies such as the TrueWind, DOE databases, and other analyses), but costs may rise incrementally as the more desirable sites are used, and as other regions increase their demands for renewable resources. (The NEMS model uses a cost multiplier to represent this effect)
- **Surplus conditions:** One of the key issues that arise in Puget Sound is the current and projected surplus condition of some utilities. For example, some may have already acquired sufficient resources to meet loads through 2020, under average water conditions. In such a situation, an RPS might require the utility to either: a) go further into surplus, and sell back excess generation to the market; b) sell off or contract existing resources. It is important to recognize that to the extent that the renewables are acquired to fulfill an RPS target, the renewable attributes (green tags, credits, etc.) of this power cannot be resold (without losing credit towards the target). In other words, were a utility to buy only enough wind power (or renewable energy credits or green tags) to satisfy an RPS, any power sold to other entities could be labeled as wind or renewable energy.

  The risks and benefits of the acquiring added renewables under surplus conditions might include:

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[2]Shaping services cover both incremental reserve margin requirements (backup capacity) and imbalance costs (replacing electricity when the wind doesn't blow as expected). Pacificorp recently estimated the added costs of bringing on 1000 MW of wind resources would be 0.3 cents/kWh for imbalance costs and 0.25 cents/kWh for incremental reserve requirements, totaling 0.55 cents/kWh (unpublished analysis "Wind Integration Costs", dated 11/12/02; also see Pacificorp 2003 Integrated Resource Plan, p. 371). This estimate was derived using a dispatch model (Prosym). For a more in depth discussion, see also Hirst, 2002. *Integrating Wind Energy with the BPA Power System: Preliminary Study*, http://www.ehirst.com/publications.html, which found that "the cost to integrate wind with the BPA power system, including adjustments for DA forecast errors and RT regulation and load following requirements, is likely to be well under 0.5 cents/kWh of wind output for 1000 MW of wind capacity."

- Financial losses if the utility sells excess power for less than cost of new renewable resource acquisition, because
    - Any premium paid for renewables cannot be recouped in market sales
    - Any added debt burden drives up borrowing costs
- Financial gains if the utility sells excess power for more than the cost of new renewable resource acquisition, because
    - More frequent low water conditions create a premium for utilities longer on resources
    - The value of low carbon resources increases with concerns about carbon risk or under future emissions control systems.

The long-term fate of the Bonneville Power Administration and preferential access by customer-owned utilities is a major uncertainty affect the surplus equation.

Key Ancillary Costs and Benefits

- Jobs/local revenue: to the extent renewables are acquired nearby
- Reduced emissions of criteria air pollutants
- Reduced environment impacts of coal and other fossil fuel extraction
- Reduced vulnerability to fuel price volatility

Strategy: ES2 Public Benefit Charge (PBC) Funds for Renewable Energy

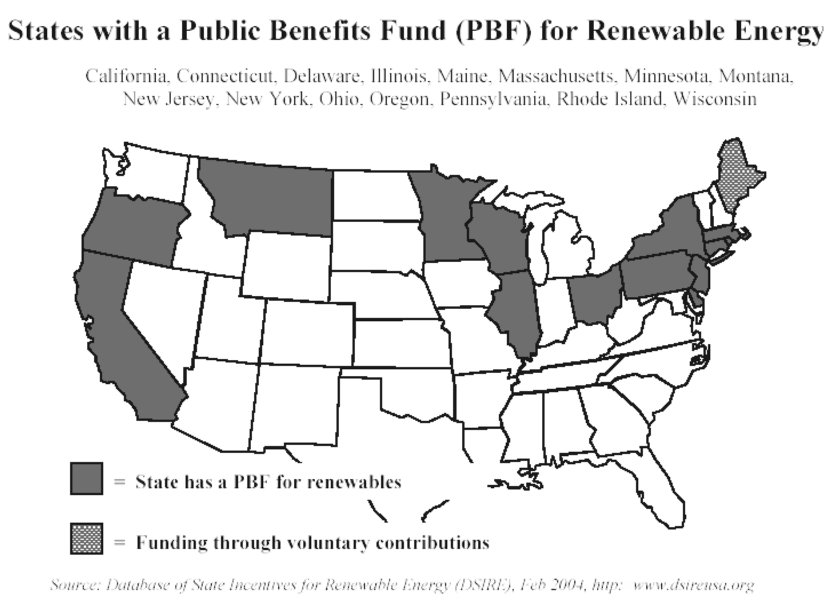
Policy/Program Description: Public benefit charges are collected as a surcharge on utility bills, and are typically directed to a mix of energy efficiency, renewable energy, and low-income programs. Typically implemented at the state-level, and often created as part of restructuring legislation and directed at investor-owned utilities (as in OR), they provide the means to assure continued support to efficiency and renewables. Public benefit funds are currently in place in about 15 states.

Examples of Public Benefits Charges for Renewables in Nearby States

Fund	PBC charge	Notes
California – Renewable Resources Trust	2-3 mills (?) (varies by utility)	Directed largely to new renewables, may be used partly to pay incremental costs of RPS resources in the future. http://www.energy.ca.gov/renewables
Oregon Energy Trust	3%	Applied to both electricity and natural gas. Funding allocations: New Renewable Energy, 19%;
Montana System Benefits Charge	1.1 mills	

Based on TWG input, we analyze this strategy as an alternative to an RPS, thus asking the question: What level of public benefit charge would be needed to achieve the same renewables targets as the RPS defined above?

While a PBC could apply to both electricity and gas (as analyzed for efficiency), for this analysis the renewables fund is assumed to be generated only from electricity bills, given that only renewable electricity resources are targeted by the RPS.



Key Results: Emissions reduction and cost impacts would similar to the RPS above, given the assumption of identical targets. Uncertainty on the fate of the PTC leads to similar uncertainty regarding the PBC bill charge required. The following results suggest that a bill charge of less than 1% (up to 0.05 cents/kWh) might be sufficient to ensure that RPS targets would be met under a no PTC scenario.

Production Tax Credit Scenario	**PTC to 2020**	**PTC to 2010**	**no PTC**
Levelized (2006-2020) Bill Cost (c/kWh)	-0.02 c	0.02 c	0.05 c

Data Sources, Methods, & Assumptions:

To evaluate a PBC for renewable energy, we:

1. Determine the annual incremental costs needed to achieve the RPS targets, per the analysis described above.
2. Assumed that a public benefit charge would be collected starting in 2006.
3. Translate this amount into an overall bill charge as follows:

$$\text{Bill charge (\$/MWh)} = \frac{\text{Levelized annual incremental cost to meet RPS target (\$/year)}}{\text{Average electricity demand, 2006-2020 (MWh/year)}}$$

Key Assumptions and Uncertainties (same as RPS above)

Implementation Issues:

- **How to implement a PBC given large uncertainties regarding incremental cost to meet renewables targets?**

Comparing Portfolio Standards and Public Benefit Charges

(June 9, 2004 draft)

Portfolio Standards and Public Benefits Charges have the common goal of promoting renewable energy technologies or energy efficiency beyond levels expected under current market structures.

- Portfolio standards set target levels for electricity retailers, typically in terms of the percentage of load provided by specific resource types, and allow some flexibility in how these targets can be met. Two standards are under consideration here:
    - A Renewable Portfolio Standard (RPS), which would require electricity suppliers to deliver a certain percentage of electricity from qualifying renewable resources, or to purchase credits from other suppliers who exceed their targets.
    - An Efficiency Portfolio Standard (EPS), which would similarly require electricity suppliers to save a certain percentage of electricity through efficiency programs and investments.

- Public Benefits Charges are included in electricity or gas bills and are collected by utilities. The PBC is typically a small charge, on the order of a tenth or three tenths of a cent per kWh. The administering agency (utility or central administrator) then invests the funds in renewable technologies and/or energy efficiency programs. The following table highlights the key differences and potential complementarities between the two approaches.

Aside from differences in implementation/administration costs, both approaches should yield similar economic impacts and co-benefits (fuel diversity, natural gas price benefits, jobs, bill savings for efficiency, air pollution reductions, etc.) to the extent they achieve similar levels of investment.

	Portfolio Standard	**Public Benefit Charge**
Key Attributes	• **Mandated target approach using a flexible, market-based mechanism.** • **Goal-oriented**: Delivers desired levels of efficiency or renewables, but with uncertain price impacts. (Can include price caps to address price uncertainties.) *Major uncertainty is cost.*	• **Central fund approach allowing flexibility in future investment patterns.** • **Price-certain:** Price impacts are defined by the level of charge (X mills/kWh), but the amount of efficiency or renewables acquired is uncertain. (Charges can be altered, but not easily.) *Major uncertainty is level achieved..*
Design Questions	• Setting appropriate/ achievable goals • Determining qualifying resources (new vs. existing), etc.	• Setting appropriate/ acceptable charge levels • Allocating funds among target programs and technologies
Flexibility	• RPS: Tradable renewable energy credits. • EPS: Ability to gain credit by investing in regional activities (Northwest Energy Efficiency Alliance, BPA programs, etc.) or	• Can easily shift priorities among technologies and programs as conditions change.

	through combined heat and power.	
Universality (small/large, IOU/COU)	*No discernable differences?*	
Administration & Implementation	• By UTC and municipalities • Implementation by Retail electricity providers (utilities)	• Administration and implementation by Central agency (i.e. OR Energy Trust) and/or utilities
Compliance & Verification	• RPS: Requires tracking system for generation attributes or certificates (can be modeled after other states) • EPS: Requires tracking system coupled with monitoring and verification. (No direct models available, could be adapted from demand-side management experience.)	• Oversight on proper use of funds by UTC or municipalities
Impact of Surplus Conditions (Note: meaning of "surplus" deserves further consideration)	• Financial loss or gain depending on whether surplus power is sold for more or less than cost. • Possible added risk and/or financing costs • Exemptions for surplus utilities are possible.	• Similar to portfolio standard, except funds can be banked or used for other purposes if cost impacts are unacceptable
Lowest cost vs. emerging technologies	• RPS: Typically focused on lowest-cost commercial technologies (e.g. wind, geothermal, small hydro), but many jurisdictions include technology-specific targets. This can ensure resource diversity and help commercialize solar PV and other resources	• PBCs often support emerging, smaller-scale and non-electricity renewables applications. (e.g. solar PV, solar water heating, biogas, etc.)
Other Issues	• RPS: Renewable credit markets can create surplus for low-cost suppliers (adding to consumer costs), but competition can drive down costs.	• PBC funds can be diverted by state government to unrelated spending or budget shortfalls if not adequately protected.
Experience to Build Upon	• RPS: 15 states have one • EPS: WA would be the first	• Over 20 states have a PBC.
Potential for Complementarity (i.e. benefits of implementing both policies)	• Renewables: RPS and PBC can be implemented in tandem as is the case in several states (e.g. CA, NJ, MA). PBC funds often support smaller, emerging technologies, while, RPS policies promote larger and lower cost resources. PBC funds can also be used to help meet RPS goals (as CA is considering). • Efficiency: An EPS could conceivably provide efficiency targets, while an adjustable PBC could provide the means to achieve the targets.	

Strategy: ES3. Incentive Policies and Barrier Reduction for Combined Heat and Power (CHP)

Policy/Program Description: From half to two-thirds of the energy used for fuel-based electricity generation is typically lost as waste heat. Combined heat and power (CHP) systems effectively capture this waste heat and supply it to a facility's process or building heat requirements, and can thereby approximately double the overall efficiency of fuel use to 80 percent or so. CHP systems can be as large as standard power plants, as is often the case for large industries and district heating systems, or small enough for small buildings and restaurants. They are typically optimized for either electricity generation or for heat delivery, depending on the heat demands of the particular facility. CHP is a well-established technology, particularly in larger industries, and is in place in much of the region's refineries and paper and pulpmills. However, they are less ubiquitous in small industries and commercial establishments.

Policies supporting CHP could include establishment of interconnection standards, appropriate tariff structures, output-based environmental regulations that reward efficiency benefits, tax credits/exemptions, accelerated depreciation, inclusion of CHP in portfolio standards, or incentives directed through public benefit funds. A long list of potential "solutions" identified at the July 2003 Pacific Northwest Combined Heat and Power Roundtable is included in the box below.[3]

Currently at least two major CHP projects are being considered in the Puget Sound region – for the South Lake Union development (in 5 MW units up to 100 MW?)[4] and for Seattle Steam (60MW).[5]

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[3] *Proceedings of the Pacific Northwest Combined Heat and Power Roundtable*, June 24, 2003, Portland, Oregon, Submitted by Energetics, Incorporated to the Northwest Power Planning & Conservation Council, August 1, 2003

[4] *Energy District for South Lake Union Phase 1 Feasibility Study*, for Seattle City Light by FVB Energy and Washington State University Energy Program, February 19, 2004. The CHP option came in 10% higher cost than the lowest cost scenario. The precise amount of CHP installed is not noted in the report. The district's peak demand is reported as 120 MW, and the report suggests only 10% of CHP electricity would be used within the district, thus 100 MW may be a low estimate. According to this study, lowest GHG emissions would result from scenarios involving deep water cooling and heat pump cooling, rather than CHP.

[5] According to Paul Prescott, head engineer, Seattle Steam, Several years ago, they considered building a small 65 MW CHP facility (using natural gas) in conjunction with their existing steam plant. However, they would have to sell the electricity for 4.5 to 5.0 cents/kWh. This is more expensive than nearby Frederickson CHP plant (250 MW) that sells electricity for 2.5 to 3.0 cents/kWh. Paul also said they are still hoping to build the CHP facility with the help of Puget Sound Energy. The have apparently submitted a proposal to build the 65 MW plant, and are waiting to see if PSE will become a partner in that effort.

Table 2. CHP Impacts

Implementation Level and/or Lead	**Could include Utilities, Air Regulators, State Legislature or UTC, Facility Managers, and/or Municipalities**		
GHG emissions reductions (Million Metric Tons CO2)	2010 2020 2005-2020	0.39 0.79 8.02	
		Gas Price A*	Gas Price B*
Net Direct Economic Costs ($million)	2010 2020	-$5 -$11	$17 $32
NPV Cost ($million)	2005-2020	-$66	$204
Mitigation Cost-effectiveness ($/tCO2)		Negative (-$8)	Medium ($25)
Key Ancillary Benefits and Costs	• potential local increase in air emissions (esp. NOx), e.g. if avoided generation sources are outside region • may increase exposure to natural gas prices and price volatility		

* See Key Assumptions and Uncertainties (below) for explanation of gas price assumptions

Data Sources, Methods, & Assumptions:
Assessing the impact of barrier removal and incentive policies is particularly challenging, since these mechanisms have yet to specifically defined, and the response is often difficult to judge. To get a rough sense of overall achievable CHP potential (assume a concerted effort with significant barrier reductions and/or incentives), we looked at a recent CHP market potential study[6], scaled WA state estimates to Puget Sound[7], and applied some judgment about the fractions of the total potentials of achievable by 2020, as illustrated in Table 3. Based on input by TWG members, we assume that in general, the industrial potential would be easier to achieve than commercial potential, and larger industry easier than small industry. We also assume that implementation of CHP in new facilities would be easier than for existing facilities.

[6] *Technical Market Potential for CHP in the Pacific Northwest*, Subtask 1-2 Deliverable, Energy International Report No. 02-1101-BR0023 for Oak Ridge National Laboratory, July 25, 2003.
[7] For instance, it is assumed that only 10-25% of statewide industrial potentials are within the 4 counties, for all subsectors but transportation equipment (80%), and 60% for commercial potentials (similar to the actual fraction of statewide gas demands).

Table 3. CHP Potentials by facility type

CHP Type	WA	*Puget Estimate*	*Fraction Achievable by 2020*	*Total PS (MW)*	Economic Potential
Existing Facilities (MW)					
Large Industrial – On Site	360	*87*	*50%*	*44*	High
Large Industrial – Export	870	*116*	*50%*	*58*	High especially in OR
Resource Recovery	27	*14*	*50%*	*7*	Moderate to high
Small Industrial	745	*291*	*25%*	*73*	Low to moderate
Commercial	2,885	*1,731*	*5%*	*87*	Low except AK
New Facilities (2002-2022) (MW)					
Large Industrial – On Site	57	*14*	*75%*	*10*	High
Small Industrial	304	*78*	*50%*	*39*	Low to moderate
Commercial	2,473	*1,484*	*10%*	*148*	Low except AK
Total Technical Potential	7,721			*466*	

Source: Energy International Report No. 02-1101-BR0023, Technical Market Potential for CHP in the Pacific Northwest, July 25, 2003

Italicized text reflects additional analysis assumptions for applicability to Puget Sound.

Table 4 shows the other analysis inputs used to calculate CHP costs, benefits, and emission savings. As shown, total estimate CHP capacity comes to 466 MW or 425 aMW by 2020, representing about 10% of regional electricity supply. This amount appears rather ambitious, though, two potential CHP projects alone – South Lake Union and Seattle Steam – might represent over a third of this estimate. For reference, some countries currently get about a third of their electricity from CHP (Netherlands, Denmark), each with nearly 800 MW in small-scale CHP units.[8]

Table 4. CHP Analysis Inputs

				Gas cost estimate $/MMBtu		Net Cost of Electricity* $/MWh		Net heat rate	Emissions (tCO2/MWh)		
Sector	MW	aMW **	% from new facilities	A	B	A	B	Btu/ kWh	CHP	Avoided	Net Savings
Commercial	235	214	63%	$4	$7	$32	$45	4856	0.26	0.48	0.22
Industrial	231	211	21%	$4	$6	$37	$48	5298	0.28	0.48	0.20

* Net cost of electricity is calculated as the levelized cost of added natural gas use plus CHP equipment divided by electricity produced. Estimates are based on a weighted average of several commercial sizes (100kW to 800kW ICEs and Microturbines) and industrial sizes (800kW to 40MW ICEs and CTs), based on previous studies and market analyses (Tellus 2002 and Onsite Sycom 2000[9])

**Capacity Factor 91% per earlier studies (8000 hrs/year)

Natural Gas Emission Factor: 53.1 tCO2/ billion Btu

Avoided Cost: $37.8/MWh average of Busbar and Delivered

[8] http://europa.eu.int/comm/energy_transport/atlas/htmlu/sschpmarpos.html

[9] Onsite Sycom Energy Corporation, The Market and Technical Potential for Combined Heat and Power in the Industrial Sector, and The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector, both prepared for the USDOE EIA, January, 2000.

Key Assumptions and Uncertainties:

- **Gas prices and avoided costs.** There is considerable uncertainty regarding the gas prices that CHP installations would likely pay. The major uncertainty relates to the fate of regional gas supply and demand. Another area of uncertainty is whether CHP installations will pay wholesale gas prices similar to those paid by electric utilities or retail gas prices similar to those paid by standard utility commercial and industrial customers. Since the TWG did not agree on a central estimate to use for gas prices, we considered two scenarios:
    - **Gas Price Scenario A:** This (lower) cost scenario presumes that CHP installations pay wholesale gas prices, based on NW Power and Conservation Council estimates. These estimates are consistent with those used to develop the NW Power Council's avoided electricity cost estimates, which are used here to evaluate CHP benefits. Therefore, this scenario provides a relatively "fair" comparison of costs and benefits of CHP projects.
    - **Gas Price Scenario B:** This second (higher) cost scenario is based on PSE avoided gas cost supply estimates for industrial and commercial gas supply ($6.0 and $6.7/MMBtu levelized, respectively). It is unclear whether the underlying wholesale gas price is consistent with the NW Power Council's. Nonetheless, this estimate incorporates some of the added gas transmission and distribution costs that some CHP installations may face.
- **Achievable potential CHP capacity.**
- **Current and projected cost of CHP facilities.**
- **GHG emissions reductions achieved.** This will depend on what other ES and B&F strategies are pursued, as well as likely alternatives to CHP, especially for new development (e.g. see South Lake Union report).

Implementation Issues:

- **Prioritizing which (if any) barrier reduction, incentive, or other policy mechanisms to pursue. (See e.g. "solutions" listed below)**

Possible CHP solutions identified by the PNWCHP Roundtable July 2003 (Mostly focused on industrial CHP)

- States adopt IEEE streamlined interconnection standards and reasonable policies regarding upgrades and cost allocation.
- Support the FERC and state rules that require reasonable interconnection of CHP plants.
- Establish easily accessible short-term transmission capacity release and ancillary service markets; consider pooling to reduce ancillary service costs.
- Investigate policy and partnership models similar to those described in the four Roundtable Case Studies summarized in this report.
- Joint industry steam host and utility funding of effective CHP projects, assuring that everyone has “a skin in the game.”;
- Improve understanding on the part of both utilities and host industries that CHP needs to be a viable business proposition for both parties.
- Create model utility up-front agreements for purchase, transmission, distribution contracts with rates and tariffs that encourage mutually beneficial CHP projects.
- Integrate CHP with demand exchange for peak capacity and regional energy needs to mitigate price peaks.
- Assess the potential for cost-effective CHP in utility integrated resource plans (IRPs)
- Consider requiring utilities to consider CHP in the IRP process by evaluating full efficiency (heat rate) when selecting resources.
- To put CHP on an equal footing with Renewable Resources and Demand Side Management, consider establishing policy that by 2006, all utilities must include cost-effective CHP in their portfolio for at least 1% of their resources
- Issue separate requests for proposals for CHP projects to meet individual utility CHP requirements.
- Treat long term Power Purchase Agreements as a rate base asset; similarly, treat demand side management actions for rate-basing.
- Create models for pooling and resource integration that will allow smaller utilities with growing loads to acquire resources prudently.
- Provide federal production tax incentives for CHP, similar to those provided for wind and other renewables.
- Provide eligibility for CHP in state systems benefit charges.
- Provide state tax advantages similar to wind power.
- Improve knowledge and understanding about combined heat and power.
- Partner with federal, state, and local government organizations, as well as associations and advocacy groups for leverage benefits and to disseminate information about CHP)

Table 2. Barriers
PNW CHP Roundtable

Market	Regulatory	Policy	Trans-mission	Technical Operations	Environ-mental	Legislative	Commercial Terms	Other
Uncertainty about BPA's post-2006 role as power supplier ◆◆◆◆◆◆◆◆ ◆◆◆	Utility control of resource decisions ◆◆◆◆◆◆◆	Lack of coordinated regional plan to address forecasted supply deficit ◆◆◆◆◆	Interconnect-ion access & costs ◆◆◆◆◆◆◆◆	Mill shutdowns ◆◆◆	CHP trips NSPS, causing project cost to rise	Non-reciprocal rules for ancillary services, e.g., CHP. Supports grid more than uses it. ◆◆◆◆	Reluctance and inability of steam host to make long-term contractual commitments ◆◆	Industry & utility needs too divergent or not well enough understood
Long-term commitments required by industrial sector ◆◆◆◆◆◆◆	Lost utility revenues ◆◆◆◆◆◆	How much CHP is out there? ◆	Firm transmission agreements ◆◆◆◆◆	Utility ability to dispatch for "reliability" ◆◆	Siting concerns of local population - air pollution, water, traffic, noise, etc.	Lack of legislative understanding about CHP ◆	100% private investor (3rd party) host fearful of contract; utility ignores CHP ◆	Utility risk aversion
High backup power cost ◆◆◆◆◆◆◆	Difficulty selling excess power which can make project unprofitable ◆◆◆◆	BPA 5(b) 9(c) uncertainties ◆	Adequate gas infrastructure (pipeline)	Inconsistent steam host ◆	Need to update environmental permit database	Need for renewable portfolio standards	Cogen expectation of full market price for a less valuable product ◆	Mistrust between all parties: customers, utilities, regulators; also lack of knowledge
Credit worthy counterparties ◆◆◆◆◆◆	Required utility infrastructure backup ◆◆◆	No uniform renewable portfolio standards - creates uncertainties for renewables	Current inability of transmission system to send price signals for "best" site for load centers	CHP technology issues: start up, reliability, performance		Water rights: consumptive use; surface/ pumping	Complex development process with "sovereign" participants	Utility/industry mismatch: loads v. production; economics v. objectives; culture
Gas cost and supply issues ◆◆◆◆	Avoided cost rates ◆◆	Subsidy optics (??)	Bias towards building transmission instead of CHP	Water shortages		Land use laws and regulations		Recent energy business climate creates suspicion of "creative deals" like CHP; PUD board reluctant to consider it.
Higher IRR scenario for host; shareholder pressure & key barriers ◆◆◆	Prudency rate reviews ◆			Mismatch of thermal & electrical loads (peak, outage, etc.)				
Industrial process requirements complicate utility resource dispatch - (diminishes spark-spread opportunities). ◆	Regional policy that ranks CHP third after energy & renewables ◆			Utility expertise in CHP				
Limited capital, credit worthiness ◆	Need for shortened sitting / permitting process ◆			Power replacement barriers				

Strategy: ES4. Greenhouse Gas Emissions Cap and Trade Program

Policy/Program Description: Emissions cap and trade programs are well-established market-based instruments that aim to reduce emissions to a given level at the lowest cost. For example, the Clean Air Act of 1992 set up a cap-and-trade program for sulfur dioxide emissions, which is widely viewed as highly successful, meeting target emissions levels at far lower costs than originally expected.

For CO2, a cap-and-trade program typically involves a) establishing a limit for state/regional power plant emissions, b) allocating emissions allowances, and c) enabling trading among participants, d) including other flexibility mechanisms (e.g. offsets); e) considering cost caps or other cost limitations; and f) dealing with leakage concerns (i.e. limiting any increase in emissions from power plants in states outside the program due to increased net electricity imports by states in the program).

Utility GHG cap and trade programs are currently under development in the European Union (ETS or Emissions Trading System) and in the US:

> *"The Regional Greenhouse Gas Initiative (RGGI or "ReGGIe") is a cooperative effort by 9 Northeast and Mid-Atlantic states to discuss the design of a regional cap-and-trade program initially covering carbon dioxide emissions from power plants in the region…[RGGI states have adopted an action plan to] develop a multi-state cap-and-trade program covering greenhouse gas (GHG) emissions. The program will initially be aimed at developing a program to reduce carbon dioxide emissions from power plants in the participating states, while maintaining energy affordability and reliability and accommodating, to the extent feasible, the diversity in policies and programs in individual states. The goal is to have an agreement on program design by April 2005 or sooner. After the cap-and-trade program for power plants is implemented, the states may consider expanding the program to other kinds of sources". www.rggi.org*

Note that the second RGGI guiding principle is that the "The program will be expandable and flexible, permitting other states to seamlessly join in the initiative when they deem it appropriate."

Therefore, one implementation option for Washington and other West Coast states might be to join RGGI and benefit from the considerable design effort currently underway. Alternatively, West Coast states could establish their own cap and trade system. Based on input from TWG members, we have analyzed cap-and-trade impacts assuming implementation across the West Coast, given that it is unlikely that Puget Sound or Washington, alone, could effectively undertake such a policy.

Data Sources, Methods, & Assumptions:
Our analysis is based on a regional application of the NEMS model (see ES1 above), which we use to simulate a West-wide carbon cap and allowance trading system. We looked at four separate scenarios:

1) **\$10/tCO2 permit cost, all other policies included.** The model simulates emissions reductions that cap and trade system would achieve, assuming implementation of the other high priority B&F (efficiency) and ES (RPS, CHP) strategies.
2) **\$20/tCO2 permit cost, all other policies included.**

3) **$10/tCO2 permit cost, all other policies included.**
4) **$20/tCO2 permit cost, all other policies included.**

The results of scenario 1 are shown in Table 5 and Figure 3 below, while the results of the all four scenarios are shown in Table 6.

Table 5. Impacts of a Cap and Trade (Scenario 1 - $10/tCO2 permit cost, all other policies)

Implementation Level and/or Lead	West Coast States	
GHG emissions reductions (Million Metric Tons CO2)	2010	0.22
	2020	0.81
	2005-2020	5.81
Net Direct Economic Costs ($million)	2010	
	2020	
NPV Benefit ($million)	2005-2020	
Mitigation Cost-effectiveness ($/tCO2)	$0-10 (not yet calculated) Permit Cost ($10)	
Key Ancillary Benefits and Costs	See below	

Table 6. Cap and Trade Scenarios - Regional implementation

			Cap & Trade, with Permit Price in 2020:			
Case:	**Reference**	**Policy**	**Scen 1 $10/tCO2**	**Scen 2 $20/tCO2**	**Scen 3 $10/tCO2**	**Scen 4 $20/tCO2**
Other Policies:	*None*	*Efficiency (B&F), CHP, and RPS*			*None*	
Puget Sound Electricity Emissions (MMTCO2)						
1990	7.8	7.8	7.8	7.8	7.8	7.8
2000	7.9	7.9	7.9	7.9	7.9	7.9
2010	9.0	7.3	**7.1**	**6.4**	**8.4**	**8.0**
2020	11.1	6.0	**5.2**	**4.5**	**8.5**	**7.9**
Emissions Reductions from Cap & Trade (MMTCO2)			*Relative to Policy Case*		*Relative to Reference*	
2010			**0.2**	0.9	0.6	1.1
2020			**0.7**	1.3	2.6	3.2

Key Assumptions and Uncertainties

- **West-wide (WSCC) impacts of a cap and trade system.** For this modeling exercise we examined the impact of a cap and trade system across the Western (not just West Coast) states. This is in part due to modeling limitations. However, this approach also helps to reflect the impact of disincentives for coal, and to a lesser extent, natural gas generation throughout the full Western (WECC) region, which might be transmitted through the broader market signals that West Coast action would create and/or emissions portfolio standards that penalizing imported carbon emitting resources (see below). It also reflects what might result from wider participation in the cap and trade system. Were West Coast states to "go it alone", and without effective leakage control mechanisms, the emissions reductions resulting from a $10/tCO2 permit price, could be lower than shown here.
- **No Production Tax Credit**
- **Evolutionary Wind Costs (per ES1 discussion)**

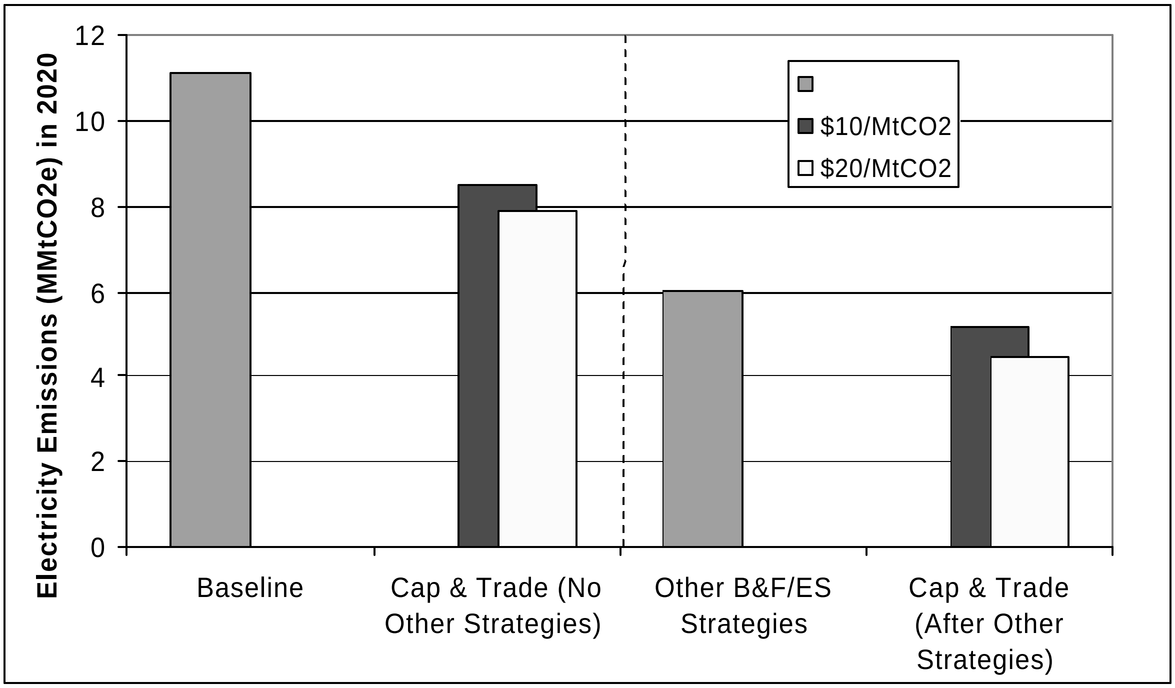
Implementation Issues:

- **Determination of cap levels.**
- **Flexibility Mechanisms.** Use of offsets, banking, and/or borrowing.
- **Permit allocation methods.** Auctions vs. allocation. Current emissions or electricity output. New vs. existing sources.
- **Administration, compliance, and enforcement.**
- **Data sources.** For consistent tracking of emissions.
- **Leakage management:** One of the major challenges of a utility cap-and-trade system is limiting "leakage", i.e. increases in emissions outside the trading system boundary that might partially offset reduced emissions within. This issue is of particular concern in the West Coast, where electricity imports from coal-rich Interior West states are typically associated with significantly higher emissions. For example, if not properly designed, a cap and trade system might discourage new gas-fired generation in Washington, and make coal-based generation in Montana more attractive. It may therefore be important to consider including
    - an **emissions portfolio standard**, which reflects the emissions of all generating resources used to meet demands (as reflected in the electricity inventory methodology for Puget Sound, and increasing adopted throughout the West Coast), rather than merely the emissions of resources located within the region.
    - **Electricity source tracking systems** that can help to ensure that the sources of imported electricity are accurately identified.

Ancillary Costs and Benefits:

- Macroeconomic impacts. RGGI modeling now underway may provide insights.
- Reduced criteria air pollutants (unless it increases local gas generation)
- Reduced impacts of coal extraction
- Potential impacts of biomass extraction and wind/geothermal development
- Potential benefits from other, project-based activities through credit markets (e.g. agriculture, forestry, etc)
- May increase pressure on natural gas prices and exposure to price volatility
- Reduced exposure to costs of future emissions reduction requirements
- Spillover effects of increased electricity rates
- Early actors may have future competitive advantage
- May create opportunities for other sectors (via credits)

Figure 3. Effect of Cap and Trade on Electric Sector GHG Emissions with (right half) and without (left half) implementation of other electricity strategies



Other regional results from NEMS runs

			Cap & Trade, with Permit Price in 2020:			
Case:	**Reference**	**Policy**	**$10/tCO2**	**$20/tCO2**	**$10/tCO2**	**$20/tCO2**
Fraction of Generation by fuel type in 2020 for WECC region						
Coal	41%	33%	28%	23%	26%	23%
Natural Gas	15%	14%	13%	15%	24%	25%
Nuclear and Oil	8%	9%	9%	9%	8%	8%
Hydro	21%	25%	25%	26%	21%	21%
Geothermal	4%	5%	5%	5%	5%	5%
Biomass	1%	2%	3%	3%	2%	3%
Solar	0%	0%	0%	0%	0%	0%
Wind	11%	11%	16%	18%	15%	15%
Generation by fuel type in 2020 for WECC region, TWh						
Coal	408	266	225	188	253	230
Natural Gas	150	115	109	118	239	243
Nuclear and Oil	78	77	77	77	77	77
Hydro	207	207	207	207	207	207
Geothermal	39	39	42	44	47	47
Biomass	14	17	22	27	20	27
Solar	2	2	2	2	2	2
Wind	109	89	129	147	143	152
Geothermal/Biomass/Solar and Wind Generation, fraction of sales for WECC region						
2020	18%	21%	27%	31%	24%	26%

ATTACHMENT 1

Costs and performance of technologies

	Conventional Coal	Coal (IGCC)	Natural Gas/Oil Combined Cycle - conv	Natural Gas/Oil Combined Cycle - advanced	Natural Gas/Oil Combustion Turbine - conv	Natural Gas/Oil Combustion Turbine - advanced
Capital Cost (2002$/kW)						
installed 2005-2011	1,184	1,447	571	645	434	486
installed 2012-2018	1,153	1,384	562	608	427	445
installed 2019-2025	1,129	1,276	552	580	420	415
Availability (%)	85	85	87	87	92	92
Fixed O&M ($/kW-yr.)	25	34	12	10	10	8
Variable costs (incl fuel) ($/MWh)						
2008	16	14	38	35	58	48
2015	15	12	42	38	64	52
2022	15	12	42	38	64	52
Typical Size (MW)	600	550	250	400	160	230
Estimate of total cost (2002$/MWh)						
installed 2005-2011	48	53	51	50	67	57
installed 2012-2018	49	53	56	53	73	61
installed 2019-2025	49	51	56	52	73	61
Heatrate (BTU/kWh)						
installed 2015	8,600	7,200	7,000	6,350	10,450	8,550
CO2/MWh						
installed 2015 - ng	0.813	0.681	0.370	0.335	0.552	0.451

Notes:
1. The total costs are based on the availability factor but may not be the capacity factor used when choosing technologies. For example, most combustion turbines are operated at much lower capacity factors, NEMS will account for most probable operating conditions when choosing which plants to build.
2. In general, capital costs reduce over time based on the assumption that costs fall as manufacturers improve their efficiencies of producing technology.
The exception is wind in 2019-2025, the increased capital cost reflects EIA's assumptions about rising capital costs as the wind sites with best access are used first so some costs rise over time while others decrease due to learning.

	Biomass	Landfill Gas - High Yield	Landfill Gas - Low Yield	Landfill Gas - Very Low Yield	Solar PV (central station)
Capital Cost (2002$/kW)					
installed 2005-2011	n/a	1,543	1,949	2,993	3,879
installed 2012-2018	1,716	1,521	1,921	2,950	3,308
installed 2019-2025	1,582	1,469	1,855	2,848	2,881
Availability (%)	83	90	90	90	24
Marginal Capacity factor					
Fixed O&M ($/kW-yr.)	45	100	131	212	10
Variable costs (incl fuel) ($/MWh)					
2008					
2015	15				
2022	15				
Typical Size (MW)	100	30	30	30	5
Estimate of total cost (2002$/MWh)					
installed 2005-2011	n/a	34	44	69	230
installed 2012-2018	57	34	43	68	212
installed 2019-2025	57	33	42	66	188
Heatrate (BTU/kWh)					
installed 2015		13,648	13,648	13,648	
CO2/MWh					
installed 2015		-6.44	-6.44	-6.44	
installed 2015 - ng	n/a				

Notes:

1. The total costs are based on the availability factor but may not be the capacity factor used when choosing technologies. For example, most combustion turbines are operated at much lower capacity factors, NEMS will account for most probable operating conditions when choosing which plants to build.
2. In general, capital costs reduce over time based on the assumption that costs fall as manufacturers improve their efficiencies of producing technology.

The exception is wind in 2019-2025, the increased capital cost reflects EIA's assumptions about rising capital costs as the wind sites with best access are used first so some costs rise over time while others decrease due to learning.

Wind Cost Estimates

	2005	2010	2015	2020	
Capital	$991	$939	$839	$728	$/kW
Fixed O&M	$26	$26	$26	$26	$/kW
Capacity Factor	40%	41%	43%	44%	
Busbar electricity	$45.4	$42.0	$36.7	$32.1	$/MWh
- w/shaping & firming	$51.4	$48.0	$44.3	$44.1	$/MWh
- w/PTC	$38.4	$35.0	$31.3	$31.1	$/MWh

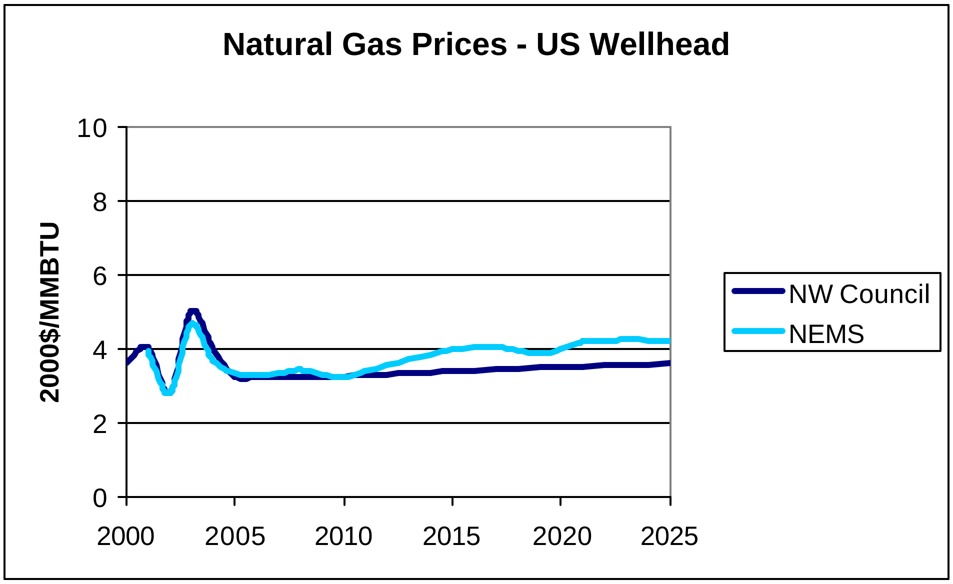
Based on
- DOE NEMS 2004 Reference Case (April 5, 2004 run)
- Wind at evolutionary status, i.e. major cost reductions still possible
- PTC Continuation, EIA Cost multipliers
- Pacificorp shaping & firming est through 2010
- NEMS capacity credit calculation for firming/shaping after 2010

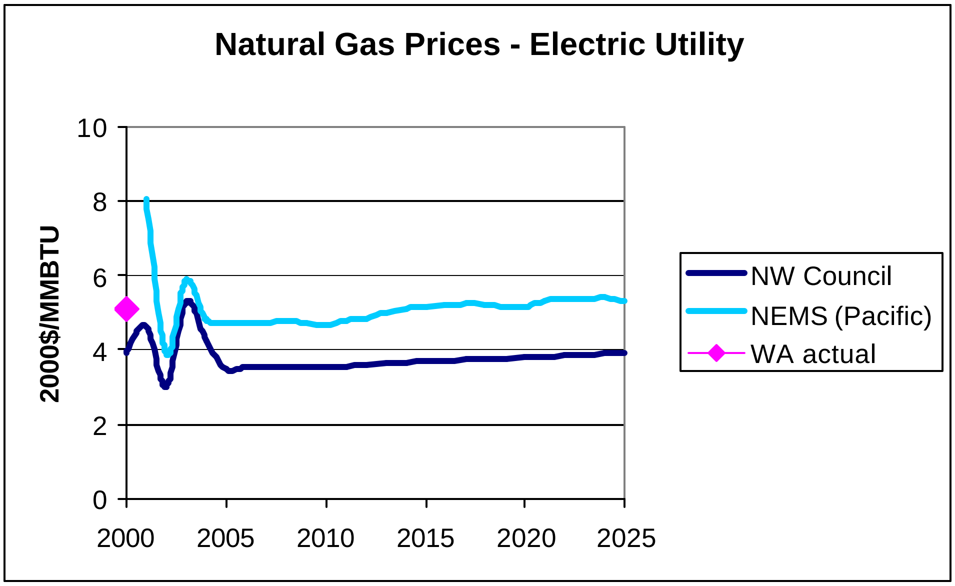
Fixed Charge Factor 13.4% based on NEMS average (2003)

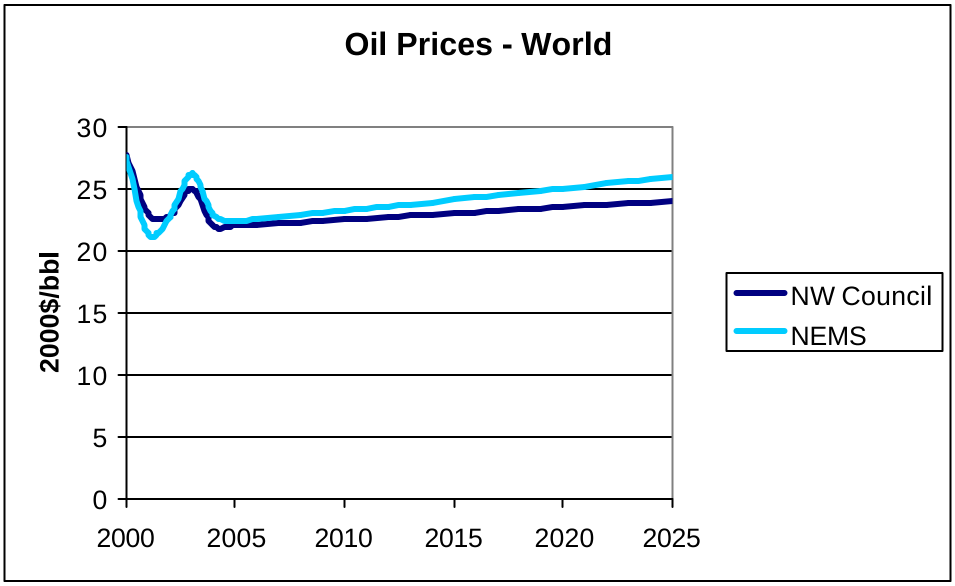
ATTACHMENT 2

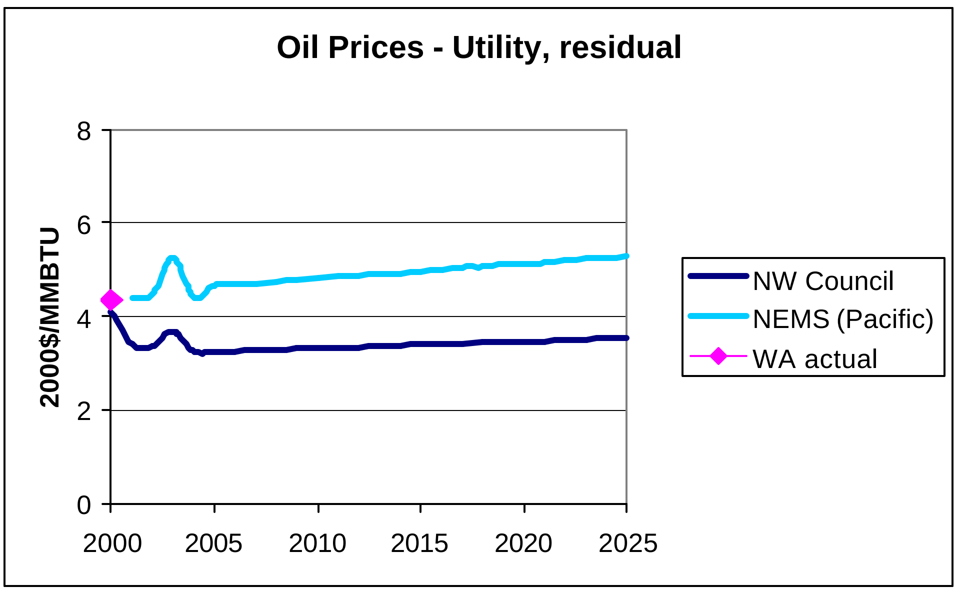
Projected fuel prices

The following figures compare the projected fuel prices from the Northwest Power and Conservation Council 5th Plan (Medium projection) with those from the NEMS model (AEO2004). For regional price forecasts, the NW Council projections refer to the Pacific Northwest region, while the NEMS projections refer to the Pacific Census Division (including Washington, Oregon and California). The values for actual Washington state prices in 2000 are from EIA's State Energy Data report 2000.






Oil Prices - World
2000$/bbl
30
25
20
15
10
5
0
2000
2005
2010
2015
2020
2025
NW Council
NEMS


Oil Prices - Utility, residual
2000$/MMBTU
8
6
4
2
0
2000
2005
2010
2015
2020
2025
NW Council
NEMS (Pacific)
WA actual

ATTACHMENT 3: Common parameters and assumptions

Common Parameters		
Earliest Start Date	**2005**	
Cost Reference Yr	**2002**	
Cost-Benefit Parameters		
Real Discount Rate	**5.00%**	
Levelized Avoided Costs - Electricity		
Avoided Electricity (busbar)	**$36.4**	$/MWh
Avoided Electricity (delivered)	**$39.1**	$/MWh
Bulk Power T&D Credit	**$3.0**	($/kw-yr)
Local Power T&D Credit	**$23.0**	($/kw-yr)
Bulk Power T&D Loss Factor	**2.5%**	
Local Power T&D Loss Factor	**5.0%**	
Combined T&D Loss Factor	**7.5%**	
Levelized Avoided Costs - Natural Gas		
Avoided Residential Gas Costs	**$7.0**	$/MMBtu
Avoided Commercial Gas Costs	**$6.0**	$/MMBtu
Avoided Industrial Gas Costs	**$4.0**	$/MMBtu
Avoided Water Supply Costs	**$2.0**	$/100cf
Avoided Water Supply Costs	0.0027	$/gal
Puget Sound Fractions of WA State Energy (2000)		
Elec		
Residential	**47%**	
Commercial	**55%**	
Industrial		
Gas		
Residential	**65%**	
Commercial	**61%**	
Industrial		

Attachment 4. Marginal electricity emission rates

Table 7. Comparison of marginal electricity emissions rates

Sources	CO2 Emission Rate MtCO2/ aMW	MtCO2 / MWh	lbCO2 /MWh	Application	Source
WECC marginal (2002-2010)	**4209**	**0.48**	**1059**	**Default marginal emissions rate used ("Net"*: 47% gas, 39% coal, 15% renewables)**	**- NPPC 02/20/04 Final**
WECC marginal (2002-2020)	2843	0.32	715		- NPPC 02/20/04 Final
WECC average (2002)	3753	0.43	944		- NPPC 02/20/04 Final
NW Power Pool (US) avg (2002)	**4277**	**0.49**	**1076**	Market purchases, direct market customers	- CTED Fuel Mix calculation
Combined Cycle Natural Gas	3253	0.37	818		- NPPC assumptions
EPA Marginal Analysis (1998 NEMS NWPP)	4776	0.55	1202	SCL and Climate Trust portfolio & offset GHGs	- used by SCL, Climate Trust
OR Governor's Process (draft)	3239	0.37	815	New resources = 30% gas, 30% coal, 40% wind	
WECC marginal (2002-2010)*	2963	0.34	745		- NPPC 03/19/04 BaU
WECC marginal (2002-2020)*	3363	0.38	846		- NPPC 03/19/04 BaU

* "Net" means that this includes the effect of backing down some existing gas and coal generation, as new sources come on-line. Were this effect excluded this mix would yield a higher emissions rate.

Table 8. WECC Resource Mix (Final 02/20/04 Aurora Run)

	Source of added generation		*Fuel mix in year:*		
Generation type	**2002-2010**	**2010-2020**	**2002**	**2010**	**2020**
Coal	**38%**	**16%**	*33%*	*34%*	*31%*
Gas	**45%**	**30%**	*18%*	*23%*	*24%*
Gas cogen	2%	0%	*4%*	*3%*	*3%*
Hydropower	2%	0%	*31%*	*26%*	*22%*
Biomass & MSW	1%	1%	*2%*	*1%*	*1%*
Nuclear	0%	0%	*8%*	*7%*	*6%*
Wind	**8%**	**51%**	*1%*	*2%*	*10%*
Geothermal	3%	1%	*2%*	*2%*	*2%*
Other	0%	1%	*1%*	*1%*	*1%*
	100%	100%	100%	100%	100%

Table 9. NWPP Resource Mix (Final 02/20/04 Aurora Run)

	Source of added generation		*Fuel mix in year:*		
Generation type	**2002-2010**	**2010-2020**	**2002**	**2010**	**2020**
Coal	**52%**	**0%**	*15%*	*19%*	*18%*
Gas	**39%**	**-3%**	*7%*	*10%*	*9%*
Gas cogen	2%	0%	*2%*	*2%*	*1%*
Hydropower	0%	2%	*70%*	*62%*	*58%*
Biomass & MSW	-1%	0%	*2%*	*1%*	*1%*
Nuclear	0%	0%	*4%*	*4%*	*4%*
Wind	**8%**	**101%**	*0%*	*1%*	*9%*
Geothermal	0%	0%	*0%*	*0%*	*0%*

Other	0%	0%	*0%*	*0%*	*0%*
	100%	100%	100%	100%	100%

Table 10. WECC Resource Mix (BaU 03/19/04 Aurora Run)

	Source of added generation		***Fuel mix in year:***		
Generation type	**2002-2010**	**2010-2020**	**2002**	**2010**	**2020**
Coal	**36%**	**75%**	*33%*	*34%*	*40%*
Gas	**29%**	**4%**	*18%*	*20%*	*18%*
Gas cogen	2%	0%	*4%*	*3%*	*3%*
Hydropower	2%	0%	*31%*	*26%*	*22%*
Biomass & MSW	1%	1%	*2%*	*1%*	*1%*
Nuclear	0%	0%	*8%*	*7%*	*6%*
Wind	**26%**	**21%**	*1%*	*5%*	*7%*
Geothermal	4%	0%	*2%*	*2%*	*2%*
Other	0%	0%	*1%*	*1%*	*1%*
	100%	100%	100%	100%	100%

Appendix K - Transportation Technical Appendix

This appendix represents the results of the supporting technical analysis, as guided by the Transportation Technical Working Group (T TWG). The individual strategies are discussed in the following groupings:

This provides an overview of initial research and quantification approaches for Transportation Technical Working Group of the Puget Sound Clean Air Agency's (PSCAA) climate change stakeholder process. It includes key questions and potential research priorities, including citations, key reports or other sources for further information.

<u>Outline of Policy or Program Description for the Transportation TWG</u>

- Policy or Program Description
- Key Results '000 tCO_2e & costs
- Data Sources, Methods, & Assumptions
- Ancillary Costs & Benefits (as needed)
- Implementation Issues (as needed)
- ***Questions and Data Requests for TWGs*** *(w/ citations in yellow for key reports to review)*

Strategy: California LEV II Vehicle Standards (CA LEVII)

I. Motor Vehicles

Typical Data Needs to Estimate Puget Sound LDVs Emissions

• Fleet Size (private, gov't, other:	7,500 passenger vehicles
• Annual Average VMT per Vehicle:	12,000 miles
• Percent of Fleet Replaced:	10%
• Average GHG emissions of Current Fleet:	g/CO2 per mile (on-road)
• Average GHG emissions of New Vehicles:	g/CO2 per mile (on-road)
• Fuel Price:	$1.50 per gallon
• CO_2 Emission Rate:	9.816 kg CO_2 per gallon

Note: Life-cycle GHG savings will be reduced by 20 percent to reflect the portion of GHGs that are direct tailpipe emissions.

Policy/Program Description: The California Low Emission Vehicle II (LEV II) program establishes strict emission standards for all new cars sold in California as well as for any other state that adopts the program.

California's Low Emission Vehicle (LEV II) Standards

California LEV II Standards are an update to the state's original Low Emission Vehicle program and are an alternative to federal vehicle emissions standards. It consists of two primary components:

- The Low Emission Vehicle (LEV) component requires 90% of new cars and light duty trucks meet strict new tailpipe and evaporative emission standards.
- The Zero Emission Vehicle (ZEV) component requires the remaining 10% of new vehicles to have zero emissions. These include electric vehicles or hydrogen fuel cell vehicles. The advanced technology components of the LEV II standards are summarized in the Table 1 below.
    a. **Auto manufacturers may substitute certain vehicles such as hybrid electric cars and "Partial ZEVs" for ZEVs.**
        i. These cars do not get full credit for a ZEV vehicle, so manufacturers must produce and sell more of these vehicles to meet the 10% ZEV requirement.
        ii. Because of these substitutions, the State of California estimates that 57% of new passenger cars will be Partial ZEVs, including hybrids, by 2010 and 73% by 2020.

Federal Tier 2 Emission Standards

The federal government also has new regulations that went into effect in 2004. They require tighter tailpipe and evaporative emissions controls in new passenger cars and light duty trucks.

- Auto manufacturers are required to meet similar emission limits for cars and light duty trucks to the LEV II program. (I.e, 90% component of LEV II)
- The federal program does *not* have the ZEV or the PZEV/hybrid substitute requirement.

Areas of Agreement

- Only states can opt into California LEV II standards.
- Tier 2 and LEVII have similar impacts in reducing:
    - Organic gases including cancer-causing/toxic chemicals such as benzene, formaldehyde and 1,3 butadiene. These chemicals also contribute to ozone formation.
    - Nitrogen oxides (NO_x)
    - Carbon monoxide (CO).
- Analyses by CCAP estimate GHG reductions (approximately 0.15 MMTCE in 2020) are attributable to the ZEV component of the California LEV II standards.
- A state must first adopt the California LEV II standards if they want to adopt California's greenhouse gas motor-vehicle reduction standards.

Areas of Uncertainty

Fuels

- California also has its own reformulated gasoline which contains low levels of sulfur. This helps California cars reach the LEV II emission standards, although there is uncertainty about the amount. EPA requires low sulfur fuels in all states beginning in 2005 and fully available by 2009.

- Washington already receives some low sulfur gasoline from 3 refineries. One refiner, BP, supplies about 25% of Puget Sound fuel, produces gasoline with very low sulfur and reduced benzene levels comparable to California fuel.

Exhaust emissions

- Both the California standards and the newer federal standards will reduce toxics and NOx emissions from cars and light duty trucks.
- ZEV/PZEV vehicles have even lower exhaust standards**.** The technologies include larger and more advanced catalytic converters.
- EPA analyses conclude that the California standards reduce VOC/toxics by 1-2% over federal standards;[1] one study by a consortium of air pollution agencies estimates toxics reductions of approximately 25% over federal standards.[2] Similar analyses by the State of California also estimate approximately 35% reduction in VOC/toxics over federal standards.[3,4]

Evaporative emissions

- The two standards have similar evaporative emission standards for general or typical cars and trucks. Even though the evaporative emissions are lower for California LEV II cars, the standards are expected to achieve similar reductions because the same technologies are expected to be used on federal and LEVII vehicles.

Table 1: Comparison of LEVII and Tier 2 Federal Standards

<table>
<tr><th colspan="7">Comparison of LEVII vs. Tier 2 Federal Stanards</th></tr>
<tr><th>Vehicle Category</th><th>Examples</th><th>Credits per Vehicle</th><th>% of New Vehicles</th><th>Air Quality vs. Tier 2</th><th>GHGs vs. Tier 2</th><th>Costs vs. Tier 2</th></tr>
<tr><td>Tier 2</td><td>applies to all vehicles</td><td>N/A</td><td>100</td><td>low evap standards</td><td>N/A</td><td>N/A</td></tr>
<tr><td>LEV</td><td>applies to all vehicles</td><td>N/A</td><td>90</td><td>low evap standards</td><td>+/-</td><td>same</td></tr>
<tr><td>ZEVs</td><td>Electric vehicles, fuel cells</td><td>1</td><td>2</td><td rowspan="3">zero evaporative emissions standards for 15-years</td><td>fewer</td><td>higher</td></tr>
<tr><td>Advanced technology AT-PZEVs</td><td>Prius, Insight, Honda Civic CNG</td><td>0.6 (HEV) - 2.8 (Fuel Cell)</td><td>2</td><td>fewer</td><td>lower</td></tr>
<tr><td>PZEVs</td><td>24 models available (e.g., BMW 325i, Nissan Sentra,</td><td>0.2</td><td>6</td><td>+/-</td><td>+/-</td></tr>
</table>

[1] Northeast States for Coordinated Air Use Management (NESCAUM). White Paper: Comparing the Emissions Reduction of the LEVII Program to the Tier 2 Program. October 2003.
[2] NESCAUM, 2003.
[3] CARB spreadsheet analysis compared to EPA spreadsheet analysis provided by Paul Hughes, California Air Resources Board to Bob Saunders, Washington Department of Ecology. June 18th, 2004.
[4] Several reviewers asked why the results in the studies differed. Both NESCAUM and CARB suggested that EPA may have used different assumptions in how auto companies would comply with the Tier 2 standards.

Data Sources, Methods, & Assumptions:
Assumptions used to calculate GHG emissions reductions include the following:

- AT penetration using straight-line projection of AT-PEVs (hybrids) and PZEVs but no ZEVs (not market ready).
- Starts in model year 2009; reaching the full requirement by 2020.
- Uses a 9% increase in fuel economy (delta) from 2008 to 2020; based upon the US Department of Energy's Energy Information Administration anticipated technology improvements over the next 20 years.
- Applies a 4% vehicle turnover rate per WA DOL
- 50% AT-PEVs (hybrids) operating at full technical potential by 2020
- 50% P-ZEV obtain no net GHG impact
- Life-cycle GHG savings will be reduced by 20% percent to reflect direct tailpipe emissions

Key Ancillary Costs and Benefits

- Consumer savings: HEVs can offer significant lifetime savings assuming 13,000 miles driven per year, $2.00 gasoline prices, $2,000 incremental vehicle cost for a HEV
- Consumer costs: A $250 incremental cost was assumed for the share of SULEVs to meet the LEVII requirements
- WA Administrative costs: The Washington Department of Ecology estimates the LEV II program would require one additional staff person responsible for tracking and monitoring new vehicle availability and sales and working with automakers to report to US EPA on how industry is complying with the standards. However, there are flexible mechanisms that allow LEV states to partner in order to collaborate and streamline program administration (e.g., share information, reporting forms, etc.).
- Industry costs: Auto manufacturers and dealers may face increased state-specific certification requirements, internal administration of different warranties, internal accounting changes, monitoring of vehicle distribution, state reporting requirements, legal issues, and other related administrative activities.

Data Sources, Methods, & Assumptions:
Possible Quantification Approach: The GHG benefits of adopting more stringent motor vehicle emission controls may be able to calculated using the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model developed by Argonne national laboratory and the University of Chicago.

Implementation Approach: Only Washington may adopt the California GHG emission standards by the authority granted by § 177 of the Clean Air Act. Typically, this would occur legislatively or administratively by reference to the specific California regulations.

Strategy: California Vehicle CO_2 Standards

POLICY/PROGRAM DESCRIPTION: California is developing regulations to reduce motor vehicle emissions of GHGs. By January 1, 2005, the California Air Resources Board (CARB) is to develop and adopt regulations that achieve "the maximum feasible and cost-effective reduction of GHG emissions" from passenger vehicles and light-duty trucks whose primary use is noncommercial personal transportation.[5] The regulations will go into effect in January 2006 and will apply to motor vehicles manufactured in model year 2009 and thereafter. Criteria to be used in determining "maximum feasible and cost-effective" include ability to be accomplished within the time provided, considering environmental, economic, social, and technological factors, and economy to vehicle owners and operators, considering full life-cycle costs of a vehicle. CARB is required to consider the technical feasibility of the regulations and to consider their impact on the State's economy, including jobs, new and existing businesses, competitiveness, communities significantly affected by air contaminants, and automobile workers, and related businesses in the State. *CARB is also to provide flexibility, to the maximum extent feasible, in terms of complying with the regulations*. CARB must ensure that any alternative methods for compliance achieve equivalent or greater reduction in GHGs.

Data Sources, Methods, & Assumptions:
Modeling Estimates: The GHG savings were calculated using 1) a vehicle stock turnover model (which accounts for changes in the on-road fleet from both new and old or retired vehicles) developed by Oak Ridge National Laboratory.
Assumptions used to calculate GHG emissions reductions

- GHG Standard: Starts in model year 2009 and low-GHG vehicles are phased in staring in the near-term (2011) until the fleet average reaches 30% by 2020.
- Baseline. Under the staff early credit proposal, manufacturer fleet average emissions for model years 2000 - 2008 would be compared to these standards on a cumulative basis.[6]
- Pavley standards for Puget Sound region: 2.96 $MMTCO_2$ savings in 2020
    - 8% increase in fuel economy (delta) from 2009 to 2020, based upon US DOE's anticipated technology improvements over the next 20 years.
    - Applies a 4% vehicle turnover rate and a vehicle life of 16 years
    - Equivalent to a 17% reduction in GHGs from Puget Sound's LDV fleet by 2020.

Additional Technical Details

- GHG Savings: based on (lifecycle) reductions from three categories of vehicle GHG emissions: 1) exhaust (75%), 2) upstream (23.5%) and 3) air conditioners (1.5%).
- Trading: Establishes average vehicle bins rates for cars and trucks and allows trading (the average of all bins must meet the GHG standard)
- Early Action Credits: The credits must be real, verifiable, surplus, and quantifiable and only from AFV projects in CA (only automakers are eligible). Any emission reduction early

[5] AB 1493, signed August, 13, 2002 (www.arb.ca.gov/cc/ab1493.pdf).
[6] If a manufacturer has fleet average emissions below the standard for that cumulative period, the manufacturer would earn credit. Manufacturers whose emissions exceed the standard over the period would not earn credit (included are CO2, CH4, N20 and HFCs).

credits earned could be used in 2009 or later, or traded to another manufacturer. A discount rate for credits of 1.2% is used. Alternative fuel vehicles are the primary way to earn EACs.

- Co-benefits: CARB staff will review non-climate impacts, leakage and EJ impacts.

There are currently only three (3) other estimates of the level of the California standards:

- The New York GHG Task Force assumed a 36% reduction in GHG emission rates,
- The Connecticut Transportation WG used an average 33% reduction for its calculations, and
- MassPIRG assumed a 30% reduction for passenger cars vehicles.[7]

Ancillary Costs & Benefits: Adoption of tailpipe standards will improve public health.

A. Savings and Costs[8]
- Consumer savings: CARB modeling uses a 16 year vehicle lifetime and calculates annualized benefits and costs for Pavley. This works out to be a net savings of $143 per $MtCO_2$ over the life of the vehicle.
  - Assumes 13,000 miles driven per year, $1.76 gasoline prices.
  - Incremental costs vary by vehicle type, with larger vehicles having generally *lower* cost associated with meeting the standards (2015 and beyond).
- WA Administrative costs: The Washington Department of Ecology estimates the LEV II program would require one additional staff person. For Pavley we might expect similar staffing requirements, but depending on the compliance mechanisms (EACs, deployment of vehicles, etc. it may require further staff).
- Industry costs: Auto manufacturers and dealers may face increased state-specific certification requirements, internal administration of different warranties, internal accounting changes, monitoring of vehicle distribution, state reporting requirements, legal issues, and other related administrative activities.

B. Compliance and Phase-in Schedules
- Pavley standard may be delayed beyond its anticipated start date of model year 2009 due to anticipated lawsuits by automobile manufactures.

C. Air Quality
- Although aimed at reducing GHGs, CARB estimates Pavley is likely to reduce certain nonmethane organic gas (NMOG) by 2.8 tones per year, nitrogen oxides (NO_x) by 0.2 tones per year and carbon monoxide (CO) by 0.1 tones per year. CARB staff is evaluating the potential for further criteria pollutant reductions.

Implementation Approach: Only Washington may adopt the California Pavely standards by the authority granted by § 177 of the Clean Air Act. Typically, this would occur legislatively or administratively by reference to the specific California regulations.

[7] The 2008 base values are 424 g CO_2 per mile and 550 g CO_2 per mile for cars and light trucks, respectively.
[8] CARB is required to consider the technical feasibility of the regulations and to consider their impact on the State's economy, including jobs, new and existing businesses, competitiveness, communities significantly affected by air contaminants, and automobile workers, and related businesses in the State. o Criteria to be used in determining "maximum feasible and cost-effective" include ability to be accomplished within the time provided, considering environmental, economic, social, and technological factors, and economy to vehicle owners and operators, considering full life-cycle costs of a vehicle

Strategy: Low-GHG tax, feebate and rebate system (g/CO2 per mile) as an alternative or prior to adoption of California standards

POLICY/PROGRAM DESCRIPTION: Use incentives and/or disincentives to influence consumer purchases of motor vehicles; charge a fee on purchases of high-emitting vehicles and provide rebate for purchases of low-emitting vehicles.

A feebate program uses both incentives and disincentives to induce consumer buying practices that reflect the negative externalities associated with the purchase of a motor vehicle, in this case, lifetime emissions of CO_2. Under a feebate system, consumers would be charged a fee on purchases of relatively high-emitting vehicles and would receive a rebate on the purchase of relatively low-emitting vehicles. A feebate program can be designed in several different ways, taking into account the classes of vehicle to be covered, the manner in which the fees and rebates are to be calculated, and the way in which those fees or rebates are to be collected.

Data Sources, Methods, & Assumptions:

- Number of statewide vehicles and classes in Puget Sound
- How can the T TWG design a GHG feebate program to minimize potential leakage? In concert w/ other NW states/the NW Regional Governor's Initiative?

Ancillary Costs & Benefits: The GHG feebate program can be designed to be revenue neutral, so that the fees collected cover rebates disbursed as well as program administration and educational initiatives; or, it could be designed to generate excess revenues for investment in other GHG reduction efforts. Cost estimation however can be difficult.

Implementation Approach: A feebate program could begin as a pilot program and be adopted on a larger scale. The larger the area covered, the more efficient a feebate program would be. Ideally this would be at the county, Puget Sound (4-county) region or for all of Washington. State or NW statewide)

Strategy: Procurement of Low-GHG Vehicles (public, private)

POLICY/PROGRAM DESCRIPTION: Within every class of vehicles (e.g., compact car, sedan, station wagon, pickup, SUV, van) there is at least a 25 percent difference in the GHG emission rate between the most and least polluting vehicle in a class. A variety of incentives and initiatives can encourage public and private owners of vehicle fleets to purchase low-GHG vehicles. This approach presents an opportunity for government to lead by example and achieve economies of scale to influence vehicle manufacturers' product offerings.

Data Sources, Methods, & Assumptions:
Currently, the Puget Sound region has a public fleet of 3,200 cars and 1,200 vans and light trucks.

Ancillary Costs & Benefits: There are likely to be higher incremental costs for more efficient or lower GHG-emitting vehicles, however, in most cases the lifetime fuel savings more than offset any incremental cost increases.

Implementation Approaches
Below we offer elements used to form one approach. However, details specific to the PS region, including a design framework, will need to be provided by the T TWG.

- Establish a procurement policy to reduce GHG emission rates for its fleet of cars and light trucks, whether owned, leased, or contracted.
- Tax credits for Low-GHG Vehicles (included in VMT strategies as fuel or VMT tax?)
- Partner with nearby states and localities.
- Establish an outreach program (i.e., public awareness campaign)
- Work with the Federal government to advance policies that will improve the market for low-GHG vehicles (e.g., EPACT requirements do not include hybrid electric vehicles).

Strategy: Research & Development of Renewable Fuels Programs

POLICY/PROGRAM DESCRIPTION:
Encourage new initiatives and support and supplement existing efforts to develop markets for renewable fuels. Bolster public and private sector support for renewables and develop supporting infrastructure.

Data Sources, Methods, & Assumptions:
- Cellulosic, corn and soybean-based fuels reduce different amts of GHGs (65% vs. 18%).[9]
- At the end of the 1990s, about 5 million gallons of biodiesel were being consumed in the United States. By the first half of 2002, that number had risen to more than 30 million.[10]
- Key overlap w/ Ag, Forestry and Waste Group (including a possible sub TWG w/ interested parties from the T TWG and the AFW TWG)
- Current research synergies to leverage in Puget Sound or the Pacific NW, including cellulosic fuel research at Washington State

Ancillary Costs & Benefits: Job creation potential from technology-sector

Implementation Approach: TBD

[9] While a recent study questions the GHG benefits of soy-based biodiesel, there are clear data showing co-benefits, such as the reduction of particulates, from the use of biodiesel.
[10] US DOE.

II. Low GHG Fuels

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Implementation Approach: TBD

[11] While a recent study questions the GHG benefits of soy-based biodiesel, there are clear data showing co-benefits, such as the reduction of particulates, from the use of biodiesel.
[12] US DOE.

Strategy: Low Sulfur Diesel & Black Carbon Impact (on road & off road)

POLICY/PROGRAM DESCRIPTION: Encourage/support existing and planned efforts to reduce emissions from diesel vehicles.

Black carbon is defined as the absorbing component of carbonaceous aerosols (fine particles in the air) in soot (particulate matter or PM). *Most CPAC members agree that the science of black carbon is too uncertain*[13] *at this time to rely on analyses regarding potential GHG emission reductions from use of low sulfur diesel, but support the measure given the clear co-benefits of reducing toxics and particulate matter. Other CPAC members do not support incorporating the strategy as a recommended strategy in light of the scientific uncertainty).*

Potential for Control Technologies to Reduce Transportation BC
Up to half of BC emissions result from transportation, with the remainder occurring from power plants, industrial processes and the burning of vegetation.[14] Estimating transportation BC emissions is more straightforward than in other sectors. BC emissions in transportation arise solely from diesel fuel (e.g., trucks, buses and off-road/construction equipment), and the data is more readily available.

Recent federal engine and fuel regulations will play a role in reducing black carbon emissions. Specifically, these include: 1) current U.S. Environmental Protection Agency (EPA) rules which set standards for all new on-road engines that will achieve 90 percent reductions in PM beginning in 2007; 2) pending EPA rules requiring similar reductions for all new nonroad engines (to phased in between 2008 and 2014); and 3) federal fuel standards for low sulfur and ultra low sulfur. This combination of engine and fuel standards will allow for the use of new advanced retrofit technologies, which can reduce BC emissions by 90% (and in some cases up to 99%). Successful integration and use of new PM-control technologies can maximize the BC benefits while providing health benefits from reduced exposure to diesel exhaust.

Ancillary Costs and Benefits: Cost estimates developed during in the Connecticut GHG process indicate an estimated cost of $6 – 14 per MT$CO_2$e reduced.

Implementation Approaches: TBD

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[13] Recent studies on black carbon indicates it may be responsible for as much as 25% of global warming to date.
[14] Recent research from has found that up to half of black carbon is from the transportation sector (Streets, Bond).

Strategy: Freight In-Use Elements

POLICY/PROGRAM DESCRIPTION:
Freight-In-Use Elements: Improve freight traffic, including operation efficiencies, loading optimization and traffic flow. As a specific action, encourage the West Coast Diesel Collaborative to consider climate change as a critical element in its decision-making practices.

Data Sources, Methods, & Assumptions:
Truck travel is the fastest growing mode of ground transportation and is expected to increase by 76% from 2001 to 2025, exacerbating roadway congestion and contributing to GHG emissions.[15] Trucks are responsible for more than 70% of freight GHG emissions, with marine, pipeline and rail making up the majority of the remainder.[16] High growth in Port traffic and support equipment is contributing to increased GHG emissions as well as particulates. The Puget Sound's location as a key NW port provides opportunities to use alternative or low-GHG fuels in lieu of carbon-based fuels (primarily diesel). CCAP reviewed a series of studies to ensure a ful suite of low emission strategies were considered.[17]

Operating Efficiency Measures. When optimally configured, improved aerodynamics, low-rolling resistance tires, anti-idling technologies and low-friction oils and tires these and other technologies have the potential to reduce truck GHG emissions by up to 2 -6%.[18] Of note, truck stop electrification (TSE) is expanding rapidly in U.S. states and Canada because it can save truckers money in fuel costs while reducing PM emissions (and black carbon).[19]

Freight Loading Optimization. Research by the Centre for Sustainable Transport and others indicates that 70 percent of a truck's fuel consumption is used to move the truck; with the remaining 30 percent used to move the cargo. Thus, payload optimization and consolidation, reduced backhaul, etc., offers the potential for reduction of truck trips and significant gains in truck efficiency, fuel savings and GHGs reductions.[20]

Traffic Flow & Operations. Intelligent transportation systems, expanded truck tolls (e.g., electronic collections), speed limits and limited delivery times/zones, etc., can contribute to improved roadway operations which minimizes GHG emissions and may help improve daytime air quality (i.e., reduce 'ozone alerts). Such measures improve driver safety, reduce accidents and are cost neutral or in some cases revenue generators.

Ancillary Costs & Benefits: Job creation potential from increased goods movement

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[15] U.S. Department of Energy, Energy Information Administration's *Annual Energy Outlook, 2004*.
[16] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2001*. April 2003.
[17] *Freight-Rail Bottom Line Report*,[17] *Freight Capacity for the 21st Century*,[17] *Trucks, Traffic, and Timely Transport*,[17] and *Mid-Atlantic Rail Operations Study*.[17]
[18] Jeffrey Ang-Olson and Will Schroeer, ICF Consulting. *Energy Efficiency Strategies for Freight Trucking: Potential Impact on Fuel Use and GHG Emissions. 2001 Annual Transportation Research Board Meeting* and Oak Ridge National Laboratory, *Technology Roadmap for the21st Century Truck Program*, December 2000.
[19] In late 2003, the U.S. EPA issued *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity*. http://www.epa.gov/otaq/smartway/
[20] Richard Gilbert, Centre for Transport Studies, email discussion, March-April 2004.

Implementation Approach: The Freight Mobility Strategic Investment Board (FMSIB), the Transportation Improvement Board (TIP) and the FAST MOU offer a clear and comprehensive set of investment needs for infrastructure in the Port of Seattle as well as elsewhere.
TBD

III. Travel Demand Reduction

VMT Reduction Measures

POLICY/PROGRAM DESCRIPTION:

1) Establish a regional VMT reduction goal. A VMT goal should emphasize the reductions the Puget Sound region would like to achieve within a specified timeframe.

VMT Reduction Goal for Puget Sound

The Transportation Technical Working Group (T TWG) selected a series of strategy packages for reducing VMT, focusing on efficient land use, increasing transit, and reducing travel demand. Implementation of the recommended strategy packages identified by the T TWG is estimated to result in an <u>11% reduction by the year 2020 from the projected Puget Sound Regional Council forecast of 16% VMT growth</u>.

VMT reduction estimates were selected from the latest literature, relying on local estimates and where available, local modeling.[21] While it is noted that the strategies identified here are also included in Destination 2030, it was recognized by the Transportation Working Group that the 11% estimate was a goal designed to support specific actions – namely transit oriented development, parking pricing and commuter options -- which can achieve significant VMT reductions. To use a local example, it is worth noting that Portland, Oregon, a national leader in using land use measures and transit to reduce VMT, recently announced they are on track to achieve a 10% VMT reduction by 2020.[22]

2) Implement three distinct packages developed around land use-oriented actions, transit-oriented actions, and transportation demand side measures. Each package is directed towards the primary entities responsible for its implementation and contains specific actions that the CPAC emphasizes. The CPAC urges that that these actions receive priority with respect to funding and development of effective implementation mechanisms. Those actions are:

- Encourage transit-oriented development;
- Establish parking pricing and supply;

[21] For **Location Efficiency** VMT reduction and we selected a mid-point of 5%, based on national literature indicating up to 13% VMT reduction from location efficient policies. For **Transit Service** we chose a 2% reduction which was the lowest number cited by literature and assumes no new transit line expansion. For **Demand Management** we selected a 4% reduction which was the mid-point based on a 3-6% reduction from modeling conducted by Washington State's Transportation Demand Management (TDM) office.

[22] For more information, see the City of Portland, Transportation Planning Office, http://www.trans.ci.portland.or.us/planning/RegionalModeSplit.htm#Findings

- Improve transit frequency and transit options;
- Expand bike and pedestrian infrastructure; and
- Fully fund current and expanded demand-side transit initiatives.

3) Incorporate climate change considerations into regional transportation and land use planning. Existing transportation and land use planning forums represent important opportunities to consider the impact of various future actions on climate change. Specifically, the CPAC supports the efforts of the Puget Sound Regional Council and its Metropolitan Transportation Plan, Destination 2030 and believes that the policies identified in the plan will support GHG emission reduction efforts.

Data Sources, Methods, & Assumptions:
Step 1: Estimate GHG Reductions/benefits. CCAP will estimate reduction in GHGs based on local, state and regional estimates identified from national data and literature, etc. (see below)

Step 2: Refine GHG reductions. TWG suggested data and suggested refinements (e.g., local VMT data or project-specific VMT reductions or estimates from current or ongoing projects, studies, plans, etc.

Step 3: Quantify Full Suite of Reductions. Related to Steps 1 and 2, the T TWG clearly defined those measures for fuller consideration. Related questions discussed included:

- What are key *barriers* to implementation? How to overcome <u>specific</u> barriers?
- Define where overlap exists with the AF&W WG (i.e., preservation of open space)

Step 4: Estimate Regional VMT Reduction. Based on the set of measures considered, CCAP estimated that regional VMT growth would be reduced by 11% by 2020. For the full suite of measures considered please see Table 2, which includes estimated reductions from each individual low VMT strategy.

Ancillary Costs & Benefits: Cost estimates will include the fuel savings and potential infrastructure savings.

Implementation Approach:
There are several programs and policies within Washington state that could be considered as helpful here. Two of the primary examples, include:

A TDM Resource Center, created in conjunction with the CTR law, was also created with WADOT to reduce VMT in the highly congested 4-county Puget Sound region. The TDM Resource Center anticipates reducing regional VMT by 3-6 percent through investment in employer-based commute reduction strategies, vanpools, land-use and education measures. (*For more information:* http://www.wsdot.wa.gov/tdm/default.cfm)

King County, Washington is home to the nation's oldest and most successful vanpool program. Overall, the commuter vanpool has had a significant impact on the Puget Sound region – in terms of trip reduction, limiting congestion, and protecting the environment. The public vanpools in this region eliminate more than 11,000 vehicles and 22,000 trips every day, reducing

single occupant vehicle miles by 2.7 million miles annually. Vanpooling has significant environmental benefits including annual reductions in tailpipe emissions of 370 tons and annual reductions in GHGs of about 65,000 tons.
(*For more information:* www.metrokc.gov/earthlegacy/smartgrowth.htm)

Table 2: VMT Reduction Strategies

	VMT Reduction Strategies					MMTCO2		
	Policy	Range	Source/Organization	VMT Savings	Time	2010	2020	Assumptions
	Location Efficient Plans, Tools and Policies in Support of Destination 2030	**1-10%**		5%		0.24	0.73	Midrange selected recognizing this is reinforcing Destination 2030 goals for Puget Sound travel (i.e., D2030's Urban Growth Centers).
	REGIONAL or statewide analysis							
	Regional estimate for Seattle*	1-4%	Federal Highway Administration					includes infill near transit but not price or service increases
	Statewide estimate for CA	2-10%	CA Metropolitan Plannning Organization					high range sums transit service, parking pricing and infill
	Regional estimate in Portland	6-8%	LUTRAQ Technical Reports/Modeling					Land Use Transportation Air Quality project in Portland, OR uses innovative travel demand modeling to measure the impacts of transit w/ parking pricing, infill, biking, etc.
1.1	Prioritize infrastructure funding or withhold funding from greenfields	-	MD, NJ					can bolster the Urban Growth Boundaries per D2030
2.8	Fix it First	-	NA					Supports WA's Road Relief Program
3.9	**Parking pricing & supply**	2-20%	Litman, LUTRAQ Modeling					modeling shows increased parking pricing reduces regional VMT dramatically
	LOCAL or site-specific analysis							
1.2	Infill/Brownfields	15-53%	US EPA literature review					Quantified local sites in CA, MD, TX, FL
1.3	**Transit-oriented development (TOD)**	15-53%	Parsons-Brinkerhoff literature review					Households in innterconnected neighborhods have 1/2 the VMT vs. sprawl development (i.e., cul-de-sacs)
1.4	Density Standards	20-30%	Frank and Pivo					Office buildings <100 ft from transit have 30% fewer solo commuters
1.5	Locate Gov't Buildings in Centers	-	NA					Supportive of density (directionally correct)
1.6	Smart Growth, Planning, Tools	-	NA					Supportive of density (directionally correct)
3.7	Location Efficient Mortgages	-	NA					small local impact on VMT but can aid other strategies by adding to transit ridership
	Open Space Preservation (support areas identified in Destination 2030)							No VMT savings but supports UGB and D2030 programs
	REGIONAL or statewide analysis							
1.7	Targeted open space protection, TDRs, etc.	-	NA					
1.10	Support urban growth boundaries	-	NA					
	Increased Use of Public Transit (in Urban Growth Corridors as defined in Destination 2030)	**2-10%**		2%		0.10	0.29	Lower end of range due to assumption that no new transit lines would be built by 2020 but bolsters D2030's goals of increased increased transit (service, frequency, LOS, etc.)
	REGIONAL or statewide analysis							
2.2	**Improve transit frequency, expand options to include vanpools, park-n-ride, etc.**	2-10%	Litman					~1% transit ridership increase for HH every 100 feet closer from a transit stop
2.5	**Expand bike-and-ped infrastructure**	1-2%	EPA literature review					Supports D2030 alternatives mode elements aimed at reducing SOV trips
2.6	**HOV lanes**	1-3%	Destination 2030					Part of WA TDM Resource Center
	Support Demand Side Measures indentified in Destination 2030	**3-6%**		4%		0.20	0.59	Selected mid-point based on WA TDM Resource Center estimate for VMT savings estimate (using local travel demand modeling) to account for the low change of full funding for the TDM program elements.
	REGIONAL or statewide analysis							
3.1	Tax Credits	NA	State cost figures					High credits needs and are expensive
3.2	**Commuter Choice**	3-6%	WA TDM Resource Center					WA CTR program (i.e., a portion of these savings are in the baseline)
3.3	Telecommute	2-5%	Litman					Part of Commuter Choice
3.4	VMT Tax	3-10%	travel demand modeing					Modeling shows large tax = large impact
3.5	PAYD insurance	2-10%	Litman, CCAP					Efficient policy, implementation challenges
3.8	**Congestion pricing**	0.5- 4.75%	LUTRAQ, Litman, travel demand modeling					May reduce 5-20% of peak trips
3.10	VMT offset requirements for new road or developments	NA	requires large offset price					Complements UGB and D2030 policies for Growth Areas but easy target for developers
	LOCAL or site-specific analysis							
2.7	Transit pricing incentives	-						
3.1	**Fully fund demand-side transit initiatives**	3-6%	WA TDM Resource Center					WA TDM Resource Center modeling shows cost effective programs, reduces road building and repair costs, congestion delays
	2020 VMT Reduction Target	**1-10%**		11%				

IV. Baseline Emission

Baseline and Emissions Forecasts

POLICY/PROGRAM DESCRIPTION(S):
Transportation inventory was prepared by the Puget Sound Clean Air Agency and includes CO2, CH4, and N20 for 1990 & 1999 (US EPA).

- On-road: VMT data from WADOT (HPMS), by vehicle type (e.g., LDGV, LDT, HDDV).
- Marine data was PSCAA calculations based on WA State ferry data
- Aircraft, Ground Support Equipment: PSCAA used FAA & SeaTac data and non-road model
- Non-Road: Rail companies, EPA non-road inventory

I. Status of Two Baselines
- Approx. 16% VMT growth from 2000 – 2020 based on data from PSCR (Larry Blaine).
- U.S. DOE shows about a 60% growth based on gasoline use in the Pacific NW

The 2000 GHG emissions were estimated by extrapolating 1990-1999 growth rate for each vehicle category. From a 2000 base year we projected forward using the 16% assumption for gasoline and diesel, the majority of emissions. For other modes we applied DOE estimated projections. Status: The T TWG will have to make a decision based upon two factors: 1) do we believe the growth rate of PSRC and 2) if so can we adopt, define and introduce strategies (emphasizing those in Destination 2030) that achieve this objective?

Why do the forecasts differ?
- Different economic growth assumptions?
- PSRC data is based on a bottom-up analysis using local data for the 4-county region while USDOE numbers are based on a top-down national analysis.
- Natural barriers in the Puget Sound region can help limit the extent of sprawl.
- By design, the PSRC forecast is intended to comply with State Growth Management Act

Appendices To the CPAC Report

Agriculture/Forestry/Solid Waste
Technical Work Group High Interest Strategies

Estimated Policy Option Costs Table*

PS GHG Policy Action	**Acres/Yr**	**MMTCO2 Yr**	**MTCO2/acre**	**$/acre**	**$/MTCO2**	**$Total/Yr**	**PV, 15Yr**
Cross Cutting Actions							
PS Carbon Offsets	4,212	1.456	0.0003	$5.67	$0.02	$23,882	-$247,887.41
National Carbon Offsets	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Forestry Actions							
Nonindustrial Forests	759	0.343	0.0005	$5.67	$0.01	$4,304	-$44,669.17
Industrial Forests	621	0.277	0.0004	$105.67	$0.24	$65,621	-$681,124.27
Urban Forests	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Landscape Protection (easements)	2,832	0.836	0.0003	$2,000.00	$6.78	$5,664,000	-$58,790,383.13
Landscape Protection (tree retention)	2,832	0.836	0.0003	-$2,000.00	-$6.78	-$5,664,000	$58,790,383.13
Biomass Electricity Feedstocks 2010	26,000	0.198	0.0000	$5.67	$0.74	$147,420	-$1,530,169.19
Biomass Electricity Feedstocks 2020		0.975			TBD	TBD	TBD
Expanded HWP Use	759	0.343	0.0005	$5.67	$0.01	$4,304	-$44,669.17
Expanded Local HWP	759	0.343	0.0005	$5.67	$0.01	$4,304	-$44,669.17
Residential Wood	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Burning EE

Agriculture Actions							
Centralized Manure Digesters	n/a	0.077	N/A	N/A	$0.00	$0.00	$0.00
Expanded Organic Farming	TBD	TBD	0.3320	$22.00	$0.00	TBD	TBD
Expanded Local Grown Organic Food	TBD	TBD	0.3320	TBD	TBD	TBD	TBD
Conservation Tillage	TBD	TBD	0.3320	$22.00	$0.00	TBD	TBD
Winter Cover Crops	TBD	TBD	0.3320	$22.00	$0.00	TBD	TBD
Reduced Fertilizer Emissions from Crops	TBD	TBD	0.3320	$34.20	$0.00	TBD	TBD
Reduced Fertilizer Emissions from Suburbs	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Waste Management Actions							
Landfill Methane Energy Conversion	N/A	0.172	N/A	N/A	$0.00	$0.00	$0.00

* Costs are based on a full life cycle analysis of options. For forestry options, this includes a time period that extends to 2070 in order to capture biomass growth in response to mitigation actions taken in the 2005-2020 time period. For purposes of this cost analysis, the shorter time period (including only emissions reductions for the 2005-2020 time period) was not used.

A1. Install Centralized Manure Digesters on Dairy Farms

POLICY/PROGRAM DESCRIPTION: Methane has a high global warming effect per ton relative to carbon dioxide. It is a significant waste byproduct of dairy operations that occurs during anaerobic decay of liquid manure. In some cases methane from manure storage facilities is captured through digester equipment on site and converted to direct heat use or electricity production. When methane is converted to energy it may displace higher emissions energy supplies (typically fossil fuels) and have a significant offset effect. Waste to energy conversion of methane from liquid manure is equipment intensive and requires access to energy markets, either on site or through the electricity grid. Programs that increase methane conversion to energy often rely on financial incentives, market development, or consolidation of waste methane for economies of scale. Due to the capital-intensive nature of the technology, small-scale dairy operation often cannot afford on-site digesters. By constructing centralized digesters with cost effective access to a several farms, manure from smaller farms potentially can be aggregated and processed economically. This action requires some form of market aggregation, either with public assistance or encouragement, or through private market encouragement and response. The valuation of greenhouse gas credits or offsets from these operations may be a potentially helpful incentive.

The working group recommended evaluation of a King County centralized methane digester as well as a Snohomish unit.

KEY RESULTS: Carbon dioxide and methane gas reduction from controlled processing of organic waste and capture of methane gas for energy or flaring, with potential displacement of higher emissions energy alternatives.

Worksheet

Dairy manure CH4 centralized digesters	
King County cows	6,075
Snohomish County cows	6,075
Total # cows	12,150
Tons raw manure (annual)	504,104
Mbtu's converted energy (annual)	215,429
Kwh (annual)	20,771,649
Mwh (annual)	20,772
aMw	2.37
Annual cost of 1.8 cKwh PTC	$373,890
Displaced emissions marginal rate	
avoided MTCO2e	9,970
avoided MMTCO2e	0.0100

$/MMTCO2e	$0.00
Direct methane reduction	
MTCO2e per year	77,153
MMTCO2e per year	0.0772
$/MMTCO2e	$0.00
Total GHG reductions	0.0871
$/MMTCO2e	$0.00

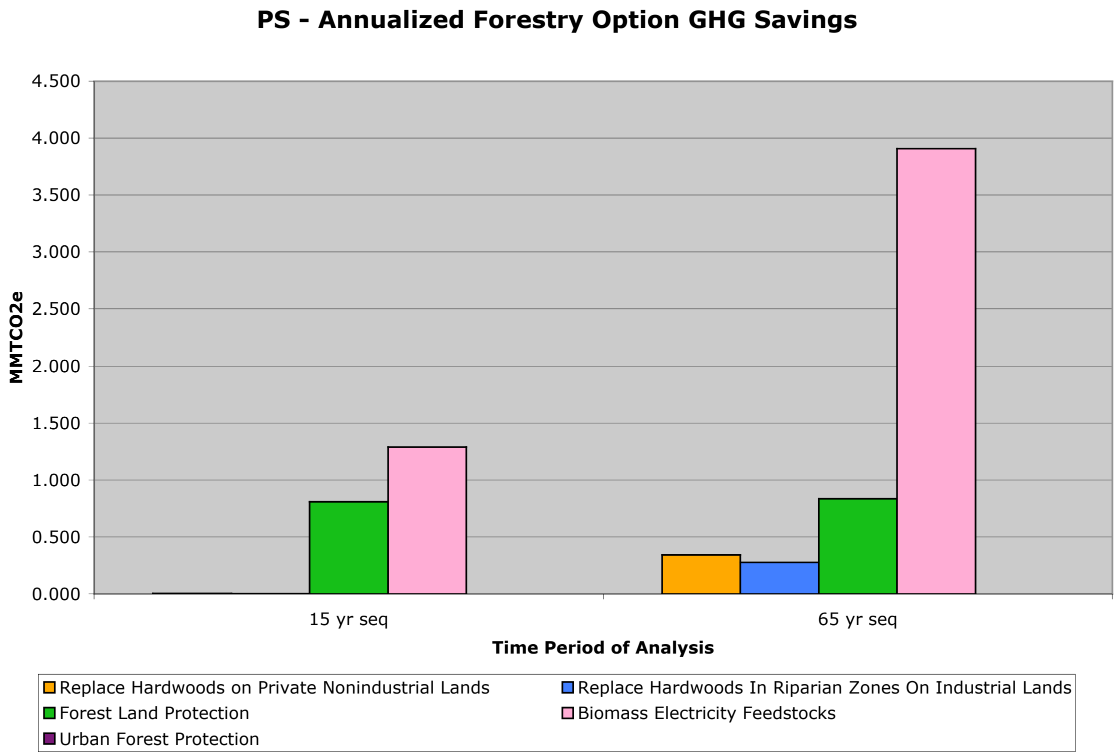
Data Sources, Methods and Assumptions:

- Data available from the King County Study by ERRG, LLC at: http://dnr.metrokc.gov/wlr/lands/2003-anaerobic-digesters-report.htm
- Costs are assumed to be zero based on market payback estimated by King County Study by ERRG, LLC.
- Electricity emissions are offset at the marginal rate of natural gas, equal to 0.48 tons CO2 per Mwh
- Estimates assume that a digester can be located proximate to 6700 cows, the same number as King County. Snohomish data From: Mike Hackett- Sustainable Agriculture Development Faculty Washington State University Snohomish County Extension. "Our estimate includes dairy cows, beef cows, and bison (American buffalo). While this figure is an estimate, it's the best we can do since farmers/ranchers do not always report total numbers, nor do all farmers/ranchers report. See that the total is 32,500. This does not include bison, which I estimate to be 120 more animals."

Key Uncertainties:

- Long-term technology costs of methane digesters
- Emissions displacement factors, particularly average power pool vs. coal
- Electricity market reference case (competing supplies, demand levels)
- Nitrous oxide reduction potential
- Impact of reducing manure application on lands using synthetic fertilizer

Summary of Proposed Forestry Options



The AFW technical work group requested analysis of forestry options using two alternate time periods for analysis. The first, a 15-year period, corresponds to the budget period of 2005-2010. The second, a 65-year period, corresponds to the full life cycle forest and the time it takes to fully regenerate from harvest. The longer time frame for analysis assumes that biomass growth after 2020 occurs as a result of a policy action taken during the 2005-2020 period.

F1a. Manage Private Non-industrial Forest Lands for Greater Carbon Savings

POLICY/PROGRAM DESCRIPTION: Forests store and emit carbon annually based through plant respiration and photosynthesis (carbon growth), as well as tree mortality (carbon removal). The degree to which forests have a net storage or emissions function depends on many factors, including management practices and commercial use of wood products and recoverable waste for energy. Some forest practices result in greater sequestration by allowing faster accumulation or longer storage of carbon in biomass or soils, or by recruiting or retaining more acreage into forestland. Biomass use for wood products or energy can offset higher energy building products or energy feed stocks and result in further greenhouse gas savings. The pattern of protected forestland on the landscape also affects travel demand and transportation emissions. A variety of implementation mechanisms can achieve these results.

The work group recommended analysis of an option to replace between one and five percent of hardwood stands currently on private nonindustrial lands (10-80 acre parcels) over a 15-year period with replacement by Douglas fir. The calculation below shows results for a five percent scenario that treats 759 acres per year over a 15-year period. Implementation mechanisms have not yet been determined.

KEY RESULTS: Carbon dioxide reductions from carbon sequestration, and expanded supplies for wood products or electricity feed stocks that may displace higher emissions alternatives.

Worksheet

Manage Private Non-industrial Forest Lands for Greater Carbon Savings		**MMTCO2e**			
		2010	2020	2010+	2020+
Acres treated per year (avg forest)	759				
Cords removed per acre	12.625				
Cft removed per acre	1,616				
Pounds removed per acre (5000 short pounds/cord)	63,125				
Wet Tons removed per acre (2.5 short tons/cord)	31.5625				
Dry Tons removed per acre (.5)	15.78125				
MT removed per acre	14.32				
MTC removed per acre (.50 conversion)	7.16				
MTCO2e removed per acre (2.079 MT CO2e/cord)	26.247375				
Total MMTCO2e removed yr 0-15	0.30				
Biomass removed					
MMTCO2 biomass removed (15 yr sum)	0.30				
MMTCO2 Products in use - storage (yr 7.5)		0.004	0.004	0.002	0.002
kMTCO2 Landfill - storage (yr 7.5)		0.002	0.002	0.003	0.003

kMTCO2 Biomass energy - annual emission		-0.009	-0.009	-0.009	-0.009
Mbtus biomass energy (17.0 Mbtus per dry ton)	1,328,292				
Mwh biomass energy (11550 btu per Kwh)	115,004				
MMTCO2 displaced (950 lbs CO2 per Mwh) annual	0	0.003	0.003	0.003	0.003
kMTCO2 Other WP - emission (yr 7.5)		-0.005	-0.005	-0.007	-0.007
kMTCO2 Forest Sequestration (DF stand replacement) (yr 7.5)		0.010	0.010	0.352	0.352
MMTCO2 from logging residue		-0.003	-0.003	-0.007	-0.007
MMTCO2 from building materials substitution		0.001	0.001	0.001	0.001
Total GHG Savings		**0.006**	**0.006**	**0.343**	**0.343**

Data Sources, Methods, and Assumptions:

- Acreage is five percent of private nonindustrial lands treated over a 15-year period. Hardwood stands were assumed to be 20 years at age of harvest, and completely replaced by Douglas-Fir.
- Static analysis assumes biomass removal and use does not affect market prices.
- Forest growth tables from Birdsey and Lewis, 1996 (Carbon Storage for Major Forest Types and Regions in the Conterminous United States). Forest regrowth was evaluated on 2020 and 2070 time horizons (stands harvested in the average stylized year of 2012.5, with 7.5 year and 57.5 year grow back periods). Forest regrowth was based on average Douglas-Fir site indices.
- Wood products and landfill storage rates from HARVCARB as reported by Birdsey and Lewis, 1996. Harvest of stands was modeled based on a stylized annual cut in year 7.5 to average the timing effects of annual harvests in years 1-15, each of which have independent and symmetrical emissions and storage functions. Emissions and storage coefficients are composites of the average stand in the Pacific NW, Westside, including: 35 percent hardwoods vs. softwoods; 2) no old growth softwood harvest; and 3) 32.5 percent of softwoods used for saw timber based on FIA data.
- Marginal emissions displacement rates from Tellus Institute, natural gas rate of 950 pounds CO2 per Mwh
- Logging residue assumed at 27 percent of total biomass harvested (Turner, 1993 as reported in Sampson and Hair, 1996)
- Emissions from mill residue are based on regional HARVCARB estimates (USFS, Skog and Nicholson)
- The effect of wood products substitution for high-energy alternatives (steel, cement) is based on estimates by Perez-Garcia, et. al,, 2004 and Lipke, 2002.

Key Uncertainties:

- Acreage available for biomass removal and restocking on nonindustrial lands.

- Program or incentive mechanism (TBD).
- Costs per acre for biomass removal; the analysis assumes all removals are commercial and therefore profitable.

F1b. Manage Forest Industry and Washington DNR Lands for Greater Carbon Savings

POLICY/PROGRAM DESCRIPTION: Forests store and emit carbon annually based through plant respiration and photosynthesis (carbon growth), as well as tree mortality (carbon removal). The degree to which forests have a net storage or emissions function depends on many factors, including management practices. Some forest practices result in greater sequestration by allowing faster accumulation or longer storage of carbon in biomass or soils, or by recruiting or retaining more acreage into forestland. Biomass use for wood products or energy can offset higher energy building products or energy feed stocks and result in further greenhouse gas savings. The pattern of protected forestland on the landscape also affects travel demand and transportation emissions. A variety of implementation mechanisms can achieve these results.

The work group recommended analysis of an option to restore native softwoods in riparian zones to increase carbon storage. This was evaluated using an initial goal of replacing up to five percent of hardwood stands currently in riparian zones (within 40 foot border of streams) over a 15-year period with Douglas fir using strict environmental practices to avoid environmental damages.

KEY RESULTS: Carbon dioxide reductions from carbon sequestration, and expanded supplies for wood products or electricity feed stocks that may displace higher emissions alternatives.

Worksheet

Replace Hardwoods In Riparian Zones On Industrial Lands		MTCO2e			
		2010	2020	2010+	2020+
Acres treated per year (avg forest)	621				
Cords removed per acre	12.625				
Cft removed per acre	1,616				
Pounds removed per acre (5000 short pounds/cord)	63,125				
Wet Tons removed per acre (2.5 short tons/cord)	31.5625				
Dry Tons removed per acre (.5)	15.78125				
MT removed per acre	14.32				
MTC removed per acre (.50 conversion)	7.16				
MTCO2e removed per acre (2.079 CO2e/cord)	26.247375				
Total MMTCO2e removed yr 0-15	0.24				
Biomass removed					
MMTCO2 biomass removed (15 yr)	0.24				

MMTCO2 Products in use - storage (yr 7.5)		0.003	0.003	0.001	0.001
MMTCO2 Landfill - storage (yr 7.5)		0.002	0.002	0.002	0.002
MMTCO2 Biomass energy - annual emission		-0.007	-0.007	-0.007	-0.007
Mbtus biomass energy (17.0 Mbtus per dry ton)	1,086,358				
Mwh biomass energy (11550 btu per Kwh)	94,057				
MMTCO2 displaced (950 lbs CO2 per Mwh) annual	0.041	0.003	0.003	0.003	0.003
MMTCO2 Other WP - emission (yr 7.5)		-0.004	-0.004	-0.005	-0.005
MMTCO2 Forest Sequestration (stand replacement) (yr 7.5)		0.008	0.008	0.288	0.288
MMTCO2 from logging residue		-0.003	-0.003	-0.006	-0.006
MMTCO2 from building materials substitution		0.001	0.001	0.001	0.001
Total GHG Savings		**0.003**	**0.003**	**0.277**	**0.277**

Data Sources, Methods, and Assumptions:

- Acreage is five percent of industrial and DNR lands treated over a 15-year period. Hardwood stands were assumed to be 20 years at age of harvest, and completely replaced by Douglas-Fir (other species may be more applicable in practice).
- Static analysis assumes biomass removal and use does not affect market prices.
- Forest growth tables from Birdsey and Lewis, 1996 (Carbon Storage for Major Forest Types and Regions in the Conterminous United States). Forest regrowth was evaluated on 2020 and 2070 time horizons (stands harvested in the average stylized year of 2012.5, with 7.5 year and 57.5 year grow back periods). Forest regrowth was based on average Douglas-Fir site indices.
- Wood products and landfill storage rates from HARVCARB as reported by Birdsey and Lewis, 1996. Harvest of stands was modeled based on a stylized annual cut in year 7.5 to average the timing effects of annual harvests in years 1-15, each of which have independent and symmetrical emissions and storage functions. Emissions and storage coefficients are composites of the average stand in the Pacific NW, Westside, including: 35 percent hardwoods vs. softwoods; 2) no old growth softwood harvest; and 3) 32.5 percent of softwoods used for saw timber based on FIA data.
- Marginal emissions displacement rates from Tellus Institute, natural gas rate of 950 pounds CO2 per Mwh
- Logging residue assumed at 27 percent of total biomass harvested (Turner, 1993 as reported in Sampson and Hair, 1996)
- Emissions from mill residue are based on regional HARVCARB estimates (USFS, Skog and Nicholson)

- The effect of wood products substitution for high-energy alternatives (steel, cement) is based on estimates by Perez-Garcia, et. al,, 2004 and Lipke, 2002.
- No clear cutting; single tree removal

Key Uncertainties:

- Political viability
- Acreage available for biomass removal and restocking on nonindustrial lands
- Site index of land
- Program or incentive mechanism (TBD)
- Costs per acre for biomass removal

F2. Expand the Use of Forest Biomass for Electricity Feed Stocks (Many Potential Sub Elements)

POLICY/PROGRAM DESCRIPTION: Biomass can be used for electricity generation by co-firing with coal, through biomass gasification, or by as direct heat. Wood energy use reduces power generation from other sources, including nonrenewable sources that may have higher emissions per unit of electricity produced (Kwh) when carbon replacement for sustainably harvested biomass is counted. The degree to which future biomass offsets current emissions from biomass combustion is affected by alternative fuel sources, power generation technology, forest practices, and time periods for analysis of biomass replacement in harvested stands.

In general, this option involves expanded use of mill residue, logging residue, chips from live and dead trees, and energy crops. It also includes electricity from existing co-firing facilities for the 2010 period, as well as new biomass gasification and combined cycle (BGCC) capacity by 2020 in addition to co-firing. Implementation mechanisms could include price incentives for biomass harvest or recovery for energy; price incentives for power generation from sustainable biomass; preferential financing for new BGCC units; regulatory preference for BGCC under portfolio standards; and siting preferences for new facilities, among others.

The option is derived from a 2002 assessments of biomass feedstock supply potential conducted by Jim D. Kerstetter, Ph.D., Washington State University Cooperative Extension Energy Program, for: 1) the 2002 Tellus Institute Report: *Clean Electricity Options For The Pacific Northwest, An Assessment Of Efficiency And Renewable Potentials Through The Year 2020, A Report To The NW Energy Coalition* (see appendices 10 and C); and 2) the 1997 *Northwest Power Planning Council Biomass Briefing Paper*. These Northwest assessments were adjusted to the Puget Sound region as noted below. Results were compared to forest inventories provided by the FORCARB model for the Puget Sound region.

NOTE: The current option only reports emissions savings associated with displaced energy and does not measure full life-cycle emissions impacts.

KEY RESULTS: Carbon dioxide reductions from carbon sequestration and displaced fossil energy.

Worksheet

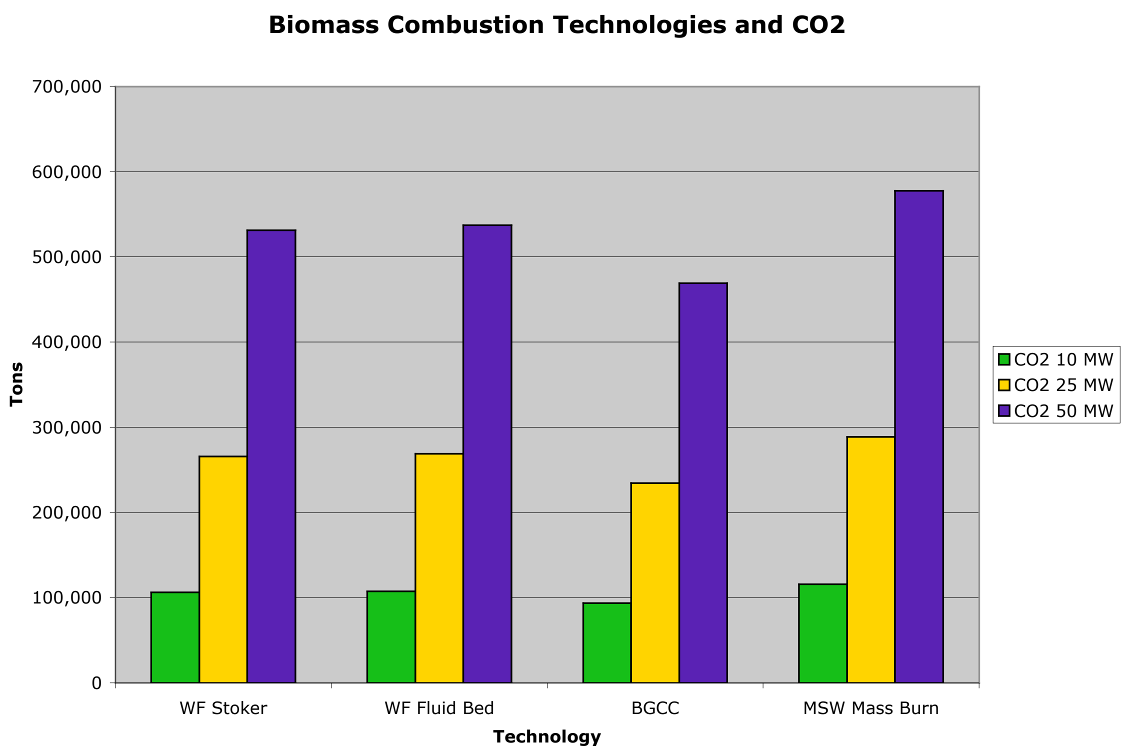
Plant	Biomass Source	$/Mbtu	bdt/yr	MMTCO2	Heat Rate	Gen Cost $/MWh	Total aMW	Exploitable aMW	% Exploitable	%PS adjust
Centralia co-fire WA	Unused mill residue	$1.50	493,000	0.82	11,550	$23.55	27	27	100%	
2000	Logging residue	$2.90	669,111	1.11	11,550	$34.00	56	11	20%	
	Forest Health	$2.90	985,244	1.64	11,550	$34.00	83	34	41%	
	Energy Crops	$1.50	75,000	0.12	11,550	$18.00	3	3	100%	
Centralia co-fire WA	Unused mill residue	$0.90	246,500	0.41	11,550	$18.00	21	21	100%	
2020	Logging residue	$2.90	669,111	1.11	11,550	$34.00	56	11	20%	
	Forest Health	$2.90	985,244	1.64	11,550	$34.00	83	34	41%	
	Energy Crops	$0.90	1,050,000	1.74	11,550	$11.00	35	35	100%	
			2,950,855	4.90	8,911	$24.48	**195**			
New BGCC WA	Unused mill residue	$1.50	246,500	0.41	8,911	$39.00	54	54	100%	
2020	Logging residue	$2.90	669,111	1.11	8,911	$52.50	73	15	21%	
	Forest Health	$2.90	985,244	1.64	8,911	$52.50	107	43	40%	
	Energy Crops	$0.90	1,050,000	1.74	8,911	$34.00	183	**183**	100%	
			2,950,855	4.90	8,911	$44.79	**417**			
PS adjusted	**Biomass Source**	**$/Mbtu**	**bdt/yr**	**MMTCO2**	**Heat Rate**	**Gen Cost $/MWh**	**Total aMW**	**PS Exploitable aMW**	**% Exploitable**	**%PS adjust**
Short term (2000)	Unused mill residue 2010	$1.50	345,100	0.57	11,550	$23.55	27	18.9	70%	70%
Cofiring	Logging residue 2010	$2.90	93,676	0.16	11,550	$34.00	56	7.7	14%	70%
	Forest Health 2010	$2.90	285,721	0.47	11,550	$34.00	83	23.8	29%	70%
	Energy Crops 2010	$1.50	52,500	0.09	11,550	$18.00	3	2.1	70%	70%
Total			776,996	**1.29**	11,550	$28.28	169	53		

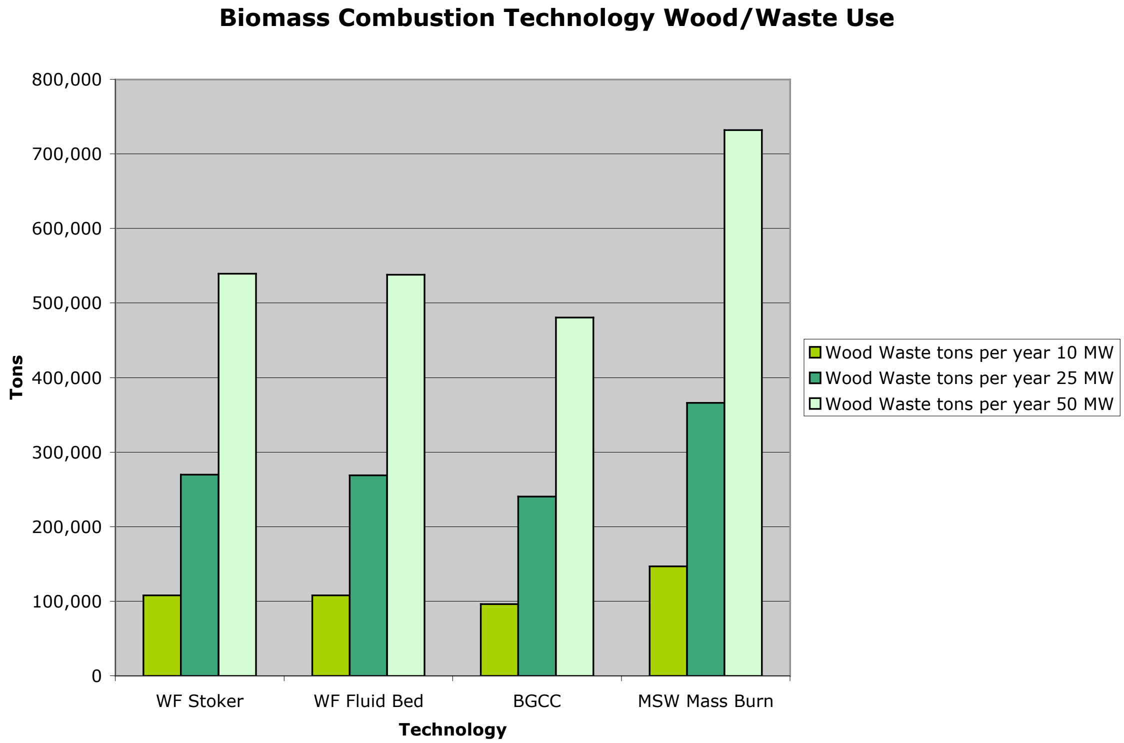
PS adjusted	Biomass Source	$/Mbtu	bdt/yr	MMTCO2	Heat Rate	Gen Cost $/MWh	Total aMW	PS Exploitable aMW	% Exploitable	%PS adjust
Long term (2020)	Unused mill residue 2020	$1.33	345,100	0.57	9,650	$33.12	75	53	70%	70%
	Logging residue 2020	$2.90	187,351	0.31	10,019	$44.73	129	18	14%	70%
	Forest Health 2020	$2.90	354,688	0.59	10,072	$44.36	190	35	18%	45%
	Energy Crops 2020	$0.90	1,470,000	2.44	10,231	$22.50	218	153	70%	70%
Total			2,357,139	**3.91**	10,105	$29.11	612	258		

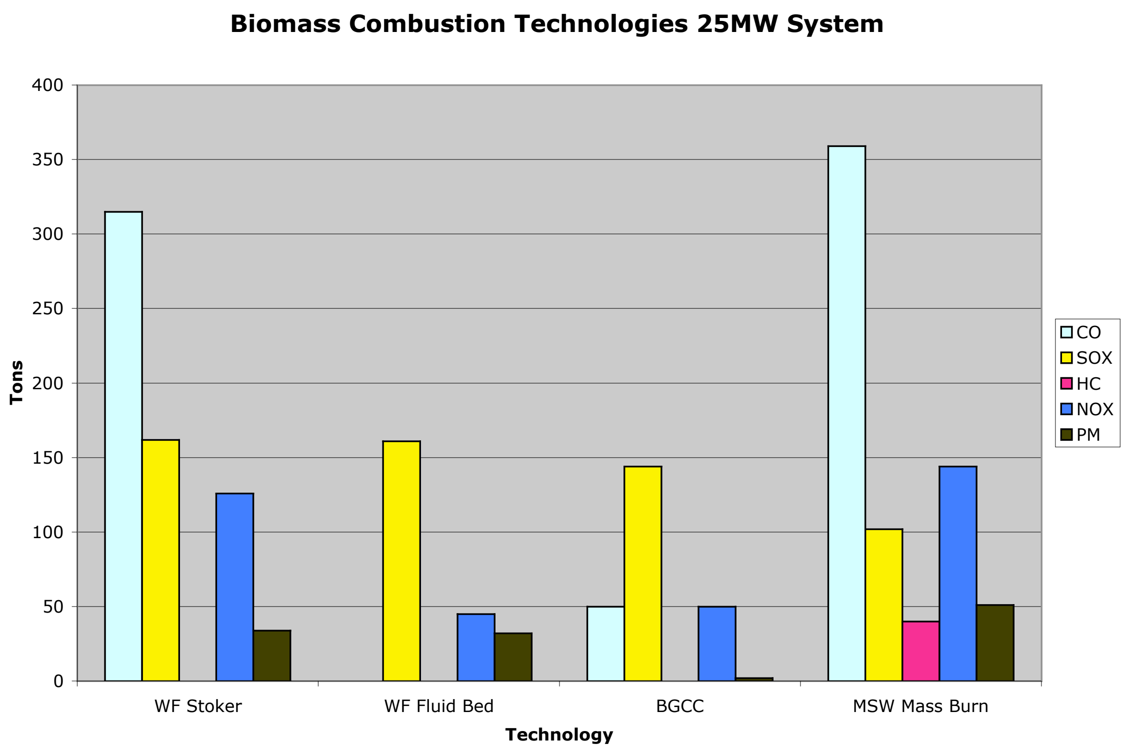
BIOMASS COMBUSTION TECHNOLOGIES

	WF Stoker	WF Fluid Bed	BGCC	MSW Mass Burn
System Performance 10 MW				
Boiler Efficiency	75.2	76.3		76.1
Heat Rate Btu/Kwh	14,421	14,383	12,818	16,437
Thermal Efficiency	23.7	23.7	26.6	20.8
Annual Capacity Factor	80	80	80	80
Wood Waste tons per year 10 MW	108,187	107,900	96,162	146,818
CO2 10 MW	106,631	107,792	93,876	115,841
CO	126		20	144
SOX	65	65	58	41
HC				16
NOX	51	18	20	58
PM	13	13	1	20
Fixed Cost $/Kw per year 10 MW	179.5	194.7	346	557
Variable mills/Kwh 10 MW	2.30	2.70	3.50	25.30
System Performance 25 MW				
Boiler Efficiency	75.3	76.4		76.2
Heat Rate Btu/Kwh	14,393	14,356	12,818	16,405
Thermal Efficiency	23.7	23.8	26.6	20.8
Annual Capacity Factor	80	80	80	80
Wood Waste tons per year 25 MW	269,946	269,241	240,405	366,350
CO2 25 MW	266,063	268,970	234,691	289,054
CO	315		50	359
SOX	162	161	144	102
HC				40
NOX	126	45	50	144
PM	34	32	2	51

Fixed Cost $/Kw per year 25 MW	99.1	108.3	181	378
Variable mills/Kwh 25 MW	2.30	2.70	3.50	25.20
System Performance 50 MW				
Boiler Efficiency	75.4	76.5		76.3
Heat Rate Btu/Kwh	14,380	14,342	12,818	16,390
Thermal Efficiency	23.7	23.8	26.6	20.8
Annual Capacity Factor	80	80	80	80
Wood Waste tons per year 50 MW	539,379	537,981	480,810	732,018
CO2 50 MW	531,621	537,439	469,382	577,569
CO	630		100	718
SOX	323	322	288	203
HC				80
NOX	252	89	101	287
PM	67	63	4	101
Fixed Cost $/Kw per year 50 MW	68.3	75.5	125	306
Variable mills/Kwh 50 MW	2.30	2.70	3.50	25.20




Biomass Combustion Technology Wood/Waste Use
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Tons
WF Stoker
WF Fluid Bed
BGCC
MSW Mass Burn
Technology
Wood Waste tons per year 10 MW
Wood Waste tons per year 25 MW
Wood Waste tons per year 50 MW


Biomass Combustion Technologies 25MW System
400
350
300
250
200
150
100
50
0
Tons
WF Stoker
WF Fluid Bed
BGCC
MSW Mass Burn
Technology
CO
SOX
HC
NOX
PM

Data Sources, Methods, and Assumptions:

- Biomass electricity generation data is based on the NW Energy Coalition Clean Energy Study by the Tellus Institute, available at: http://www.nwenergy.org/outreach/tellus_report.html and Kerstetter, 1997.
- The feedstock supply analysis includes physical, environmental, financial and market constraints. It does not include power market constraints, including capacity, competition and pricing. These issues are under review by the Energy Supply Work Group (ESWG), including development of a refined reference case for biomass technologies in the region.
- Power generation capacity in 2010 was assumed to include facilities currently operating at less than full capacity, and the recommissioning of steam units that were shut down in the 1990's due to market contraction. Capacity in 2020 includes these units plus new BGCC units to be located in the supply region to the Puget Sound market. Biomass supply estimates were derived (by the work group consultant) by selection of those sources in the Tellus report that were clearly or potentially in this supply region. See appendix 10 of the report and the background spreadsheet for detail.
- Logging residue use was limited to ten percent of available supply to address cost constraints (regional estimates show a 19 percent recovery rate).
- Mill residue included 50 percent of "miscellaneous" waste biomass currently not used for energy recapture and normally treated as an emissions source.
- Forest health refers to biomass supply that otherwise would not be harvested (but might become an emission through natural mortality). A significant amount of live biomass harvested in the Puget Sound region would involve hardwood replacement with softwoods on native softwood sites. Where density management (thinning) is practiced, harvested biomass may reduce the mortality of small trees and associated emissions. Only stands meeting a cost removal threshold of $60 per dry ton were considered as available over a 15-year period. US Forest Service lands were excluded. The translation of potential biomass supply to "exploitable" biomass by the Tellus Institute involved additional constraints for the environment, including soil structure retention, road use limitations and other criteria.
- Biomass supplies were restricted to those costing less than $3.50 per dry ton (a rough market constraint) and falling within a 50-mile delivery zone to existing facilities *or potential new BGCC sites.*
- Energy crops are based on hybrid cottonwood. The Soil Conservation Service estimates there are over 260,000 acres in Southwest Washington suitable for growing hybrid cottonwood (Columbia, 1993).
- The analysis is based on the Puget Sound power *sales* region (consumption based approach) and not constrained by power production in the region. This is consistent with ESWG approaches for power supply options. As a consequence, biomass supplies outside the region are included if they are in within the power supply market to consumers in Puget Sound.

- This static analysis assumes that biomass removal does not affect market prices. It does, however, assume that 30 percent of the harvested chips will compete in existing chip markets (and must, therefore, be price competitive).
- Marginal emissions displacement rates were used from the ESWG at 950 pounds CO_2 per Mwh (primarily a natural gas combined cycle rate, with a small fraction of coal based power).
- The current emissions analysis only evaluates displaced power from biomass feedstocks and does not count net emissions associated with harvest, regrowth, processing or combustion of biomass. To this end it is "carbon neutral".
- All biomass supplies are assumed to be additive over the reference supply case for the region.

Key resource supply issues; percent biomass available in logging residues and available acreage in Southwest Washington for energy crop planting

Logging Residue Rates And Recovery:

- Logging residue rates assumed in our evaluations are consistent with data from national studies (70% in Finland, 65% in US); percent merchantable rates appear in line with US estimates. Damage to standing live trees during logging must be added. One key issue is the residue recovery rate, and this is sensitive to removal technology and haul distance. Kerstetter used logging residue supply curves developed by Ebasco in 1986 subject to a 50-mile haul radius. Residue rates are a function of harvest volume, with some variation. Estimated recovery rates at $4.50/Mbtu average 19 percent for the region. Kerstetter and Tellus assumed 10 percent was recoverable of the "available resource" as opposed to 19 percent of the "economically recoverable" resource. ORNL assumes 40 percent of the available resource is technically recoverable on average sites, and 20 percent recoverable on steep slopes.
- Emissions from Wood Products in HARVCARB are comprised of mill residue (sawdust, shavings) and construction and demolition waste (a higher amount). Most mill residue is recovered, but much construction and demolition waste is apparently burned or dumped. Under new EPA rules dumping is replaced with landfills, but it is not clear how much C&D is burned to reduce (it appears to be high). According to ORNL: "Of the 27.5 million dry tons of fine wood residues, approximately 55.6 percent are used for fuel, 23 percent are used to produce pulp or composite wood products, 18.7 percent are used for bedding, mulch and other such uses, and about 2.6 percent are unused" http://bioenergy.ornl.gov/resourcedata/index.html#back2.

Energy crop acreage:

- A total of 66,500 acres were installed in six year hybrid poplar rotations in the Pacific, NW in 1996 http://bioenergy.ornl.gov/papers/bioen96/wright1.html. The region is a leader, and has received substantial DOE support.
- In 2002 the region had 100,000 acres in hybrid poplar with half in WA and half in OR according to Kerstetter in Tellus, 2002. Projections were made by Alig using

FASOM, and relying on land use estimates from Walsh, 1998 ORNL (methodology not defined, but irrigated acreage assumed to be less than 200,000 acres). Tellus assumes 30 percent of short rotation woody crops (SRWC) will be used for energy. HARVCARB provides default estimates of 47 percent of softwood pulp used for energy in the Pac NW. Current WA baseline is about 70,000 acres.

- "The Soil Conservation Service estimates there are over 260,000 acres in Southwest Washington suitable for growing hybrid cottonwood (Columbia, 1993)." Kerstetter, 2001. Walsh, 1998 of ORNL estimates future availability of 1.274 million acres in the Pac NW, with a cap of 200,000 on the eastside due to water availability. This leaves about 537,000 acres of cropland potentially available in western WA, and is generally consistent with the estimate of 260,000 acres available in SW WA.
- The baseline estimate from Kerstetter is 260,000 acres in short rotation tree crops in SW WA by 2020, with 30 percent use as energy feedstocks (79,800 acres).
- Walsh/ORNL estimates total nonirrigated acreage in the Pac NW region at 1 million acres.

The energy crop program has been successful due to various factors. The region has relatively high fiber prices since much of the fiber is imported into pulp mills within the region (in part due to new environmental restrictions on logging). Moreover, the west side of the mountain range receives abundant rainfall, furthermore, due to a favorable growing season; rotation cycles are relatively rapid compared with other regions. In addition, a research and development consortium was established between industry and university scientists to develop improved plant materials. Individual companies now lead breeding programs. Drawbacks to the plantation program in the Pacific Northwest are the limited land base and high demand and costs of water for the irrigation on the east side. The program has achieved much success largely due to a strong emphasis placed on tree improvement through germplasm collection and evaluation, as well as plant breeding. Approximately 20-30 operational clones exist in the region, which is 3 to 4 times higher than the average for other regions. See: Columbia Consulting Group, Business Plan Hybrid Cottonwood Cooperative Southwest Washington, Columbia Consulting Group, Issaquah WA, June 1993. Also, http://www.reap-canada.com/Reports/SRF.htm.

Key uncertainties for biomass feedstocks:

- Existing and predicted plant capacity for biomass power generation, including future BGCC
- Long term cost per Kwh of Co-firing and BGCC
- Emissions profiles of future power technologies
- Future electricity prices and demand in the region
- Future prices of competing supply sources, particularly gas
- Emissions displacement factors
- Ancillary emissions loads and factors

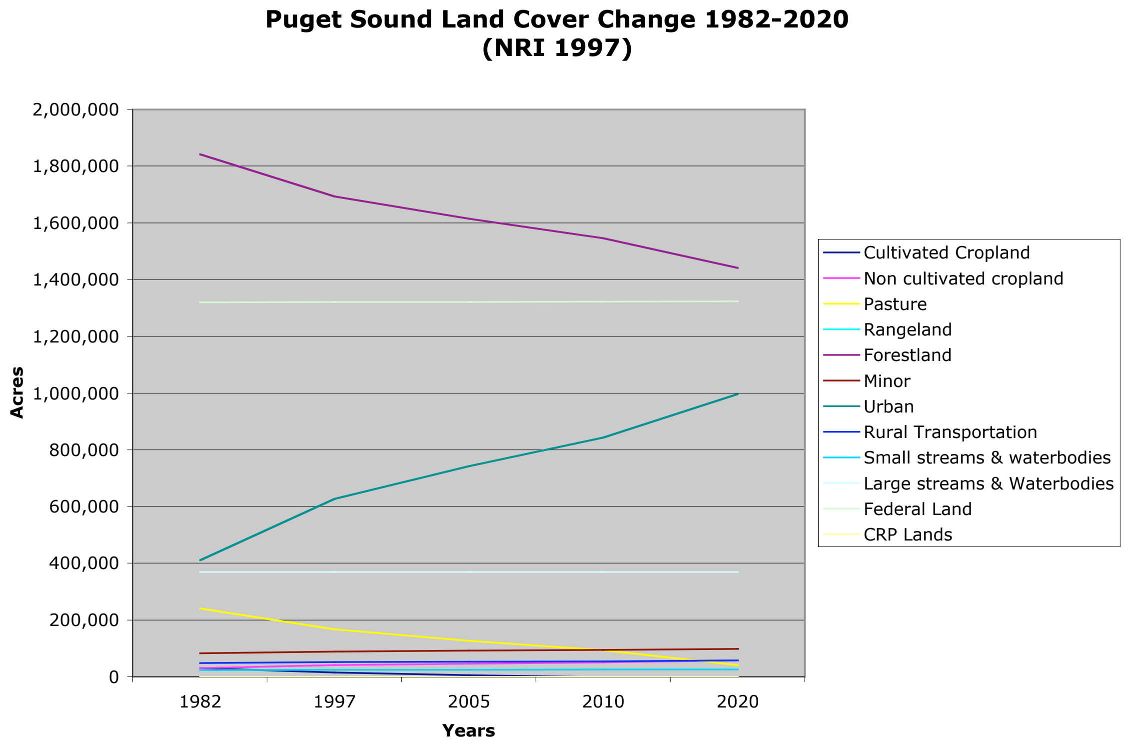
F3. Protect Forest, Agriculture and Other Natural Lands from Conversion to Other Land Uses

POLICY/PROGRAM DESCRIPTION: Forests, farms and other natural lands have the potential to produce and store carbon for very long periods through photosynthesis and fiber growth. In addition, natural lands provide biomass for wood products, electricity, heat and liquid fuels that effectively displace carbon emissions from other sources. Decisions to protect carbon supplies on these lands can protect these functions and may also significantly reduce transportation emissions associated with inefficient land use.

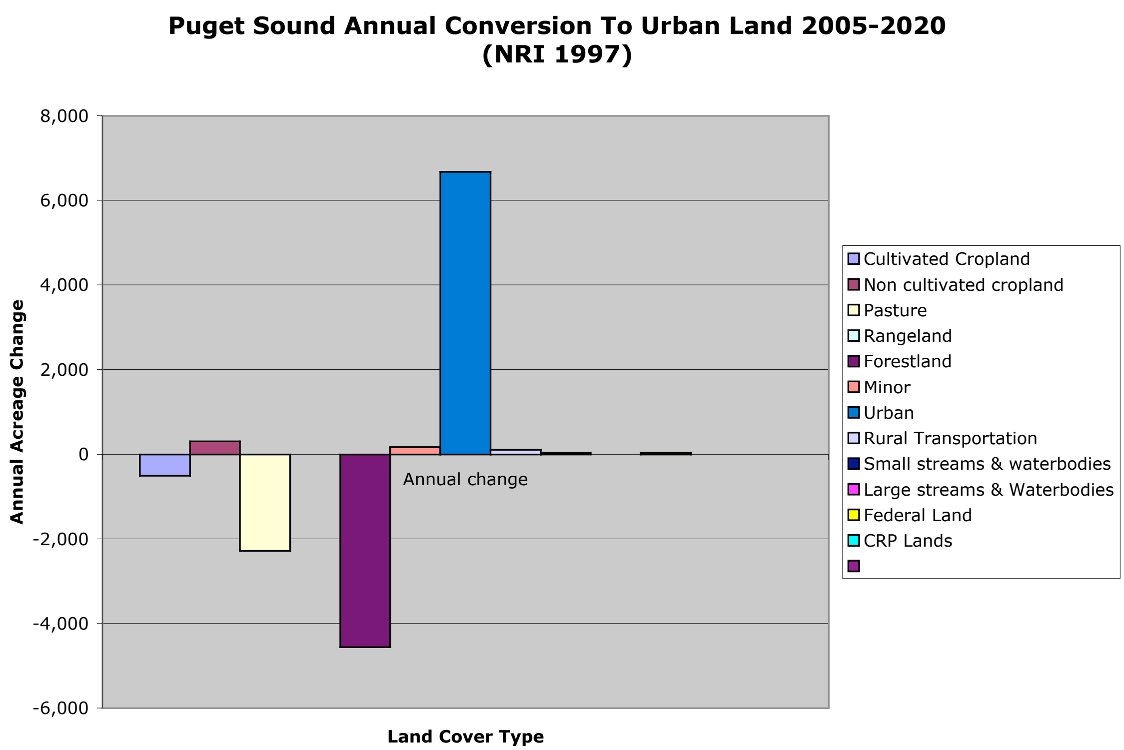
The proposed option by the AFSW TWG focuses on protection of forestland cover from loss due to conversion of forestland to developed ("urban") uses. The baseline rate of conversion from 2005 to 2020 equals 141,200 acres of forestland cover from private lands in the region (including both industrial and nonindustrial ownerships). A variety of policies can potentially reduce this rate of carbon loss and land conversion, including: financial incentives (such as tax reform and targeting of open space protection), infrastructure and service funding, regulation through zoning or planning requirements (such as lot size, open space set asides, and tree retention), transfer development rights, technical assistance and education. In 1997, the Growth Management Act (GMA) went into effect in the Puget Sound region, with several new standards and incentives affecting development patterns in the region. These include a variety of density, open space, and tree retention standards and incentives.

The proposed land protection option would apply to forestlands currently designated under GMA as urban, suburban, and rural – subject to varying standards by each of the four counties. As a consequence, goals, targets and implementation programs need to be developed for these three land ownership categories and four counties. The placeholder number for initial analysis and discussion for all three groups combined is equal to 30 percent less than forecasted forestland cover loss, or 42,480 acres of net land savings over 15 years. These rates need additional review based on baseline forecasts for each of the GMA land classes. Growth neutral policy mechanisms were recommended to reduce offsetting development in neighboring jurisdictions.

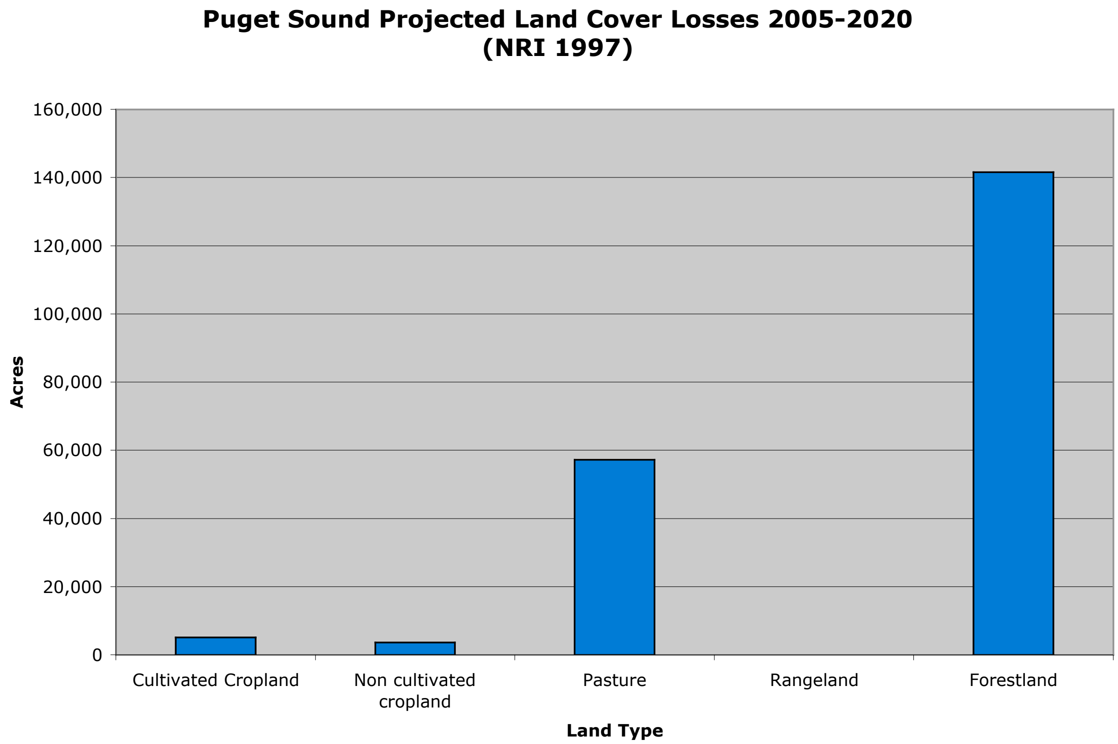
KEY RESULTS: Carbon dioxide reductions from avoided loss of carbon in tree cover and high carbon soils. Protection of future carbon sequestration and supplies for wood products or energy feed stocks, and reduced transportation (petroleum) associated with sprawl.



Puget Sound Land Cover Change 1982-2020
(NRI 1997)
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Acres
1982
1997
2005
2010
2020
Years
Cultivated Cropland
Non cultivated cropland
Pasture
Rangeland
Forestland
Minor
Urban
Rural Transportation
Small streams & waterbodies
Large streams & Waterbodies
Federal Land
CRP Lands



Puget Sound Annual Conversion To Urban Land 2005-2020
(NRI 1997)
8,000
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
Annual Acreage Change
Annual change
Land Cover Type
Cultivated Cropland
Non cultivated cropland
Pasture
Rangeland
Forestland
Minor
Urban
Rural Transportation
Small streams & waterbodies
Large streams & Waterbodies
Federal Land
CRP Lands



Worksheet

Forest Land Protection		MMTCO2e			
		2010	2020	2010+	2020+
Forest Savings					
Baseline Forest Cover Acres Lost per year (NRI)	9,440				
30% Annual Land Savings Target, acres saved	2,832				
MTC per acre saved forest biomass (nonsoil)	78.40				
MTC per acre forest soil saved - 25% loss on 2/3 acres, 100% loss 0.23acres	27.86				
MTCO2e per acre saved forest (nonsoil)	286.94				
MTCO2e per acre saved forest (soil)	101.98				
MTCO2e saved per acre per year total	388.93				
MMTCO2e total forest carbon saved on total acres per year	1.10	1.101	1.101	1.101	1.101
MTCO2e credit for wood products & landfills		-0.120	-0.120	-0.089	-0.090
MTCO2e credit for displaced		-0.068	-0.068	-0.069	-0.069

electric power					
MTCO2e credit for displaced building materials		-0.107	-0.107	-0.107	-0.107
Total GHG savings from forest cover and soils		0.807	0.807	0.836	0.836
Transportation Savings					
Acres of land cover saved 15 years	2,832				
Acres of land cover saved per year	2,832				
Housing units affected (3 home per acre LC average)	4,227				
Density increases resulting from land conservation	33.00%				
VMT per household before	22,000				
VMT per household after	20,900				
Gallons fuel reduction per HH from land conservation	51				
MTCO2e avoided per HH from land conservation/VMT annual	0.46				
MTCO2e avoided all HH from land conservation/VMT annual	0.00				
Total GHG Transportation Savings	0.0019	0.002	0.002	0.002	0.002
Option Total GHG Savings	**0.00**	**0.809**	**0.809**	**0.838**	**0.838**

Data Sources, Methods, and Assumptions:

- The current acreage goal is an arbitrary number for work group discussion that is derived by calculating 30 percent of baseline land cover losses based on NRI projections for Puget Sound counties. The total 15-year acreage goal of 42,480 acres has been divided by 15 to produce average year estimates of program savings.
- Static analysis assumes acreage protection is net above future baseline.
- Land cover is assumed to be lost at a rate of two-thirds of one acre per each acre developed of forestland. Soil is assumed to be lost at a rate of 25 percent on all acres cleared, with the exception that 100 percent of soil carbon is lost on a 10,000 square foot (0.23 acre) segment of the site that is unearthed for roads and structures.
- Household density is assumed to be one home per acre for new single-family homes located on forestland.
- Carbon emissions from cleared forest are based on USFS FORCARB inventories for Washington, Westside forests. Per acre carbon rates are based on 2002 inventory results. Biomass savings numbers are based on the retained carbon value of all biomass in the FORCARB inventory. Soil carbon savings assume that

soil carbon declines by 25 percent on the site at the time of clearing, with the exception that 100 percent of soil carbon is lost on a 10,000 square foot segment of the site that is unearthed for roads and structures.

- Carbon storage from wood products and land fills is based on 2002 FORCARB results for Washington for the Land Use Change accounts. Roughly 48 percent of softwood and 59 percent of hardwood biomass on from converted lands is non-merchantable residue. The merchantable fraction is used at the same rate as biomass from sustainably managed forests.
- Carbon savings from transportation assume households that would normally locate on undeveloped forestland locate instead on land with two-thirds less land cover loss. This translates into a 33 percent increase in density for new single-family homes. Travel savings are based on literature showing that households in smart growth locations travel between 2 and 10 percent fewer miles than conventional housing.
- Marginal electric power emissions displacement rates are from Tellus Institute, and use a natural gas rate of 950 pounds CO2 per Mwh
- Logging residue is assumed at 27 percent of total biomass harvested (Turner, 1993 as reported in Sampson and Hair, 1996)
- Emissions from mill residue are based on regional HARVCARB estimates (USFS, Skog and Nicholson)
- The effect of wood products substitution for high-energy alternatives (steel, cement) is based on estimates by Perez-Garcia, et. al,, 2004 and Lipke, 2002.

Key uncertainties:

- Percent rate of forestland cover loss in the future given GMA implementation
- Variation in county level implementation of GMA
- Percent of lots cleared during the development process
- Percent soil disturbance during development
- Emissions rates for logging residue and mill residue
- Effective implementation mechanisms
- Incremental costs

F4. Protect and Restore Urban Forests

POLICY/PROGRAM DESCRIPTION: Urban forests can provide multiple climate change benefits, including carbon sequestration, summer cooling and winter warming. Total urban forestland in the Puget Sound region has declined since the 1970's, particularly for lands with a percentage of canopy cover. By protecting and restoring individual trees and stands in the region, these trends could be slowed or reversed. Potentially, this could involve programs to encourage individual property owners as well as communities to increase tree planting, maintenance, and protection from development.

The working group has expressed interest in three potential urban forestry options:

- Protection of large residential trees from premature removal by homeowners
- Increased establishment of trees on streets and right of ways
- Increased protection of forestland cover in urban communities, including protection of forestland at risk of development

These three options require further specification and are presented as placeholders in the worksheet below. The third option could be combined with the forestland protection option.

KEY RESULTS: Carbon sequestration and, potentially, lower energy use from cooling in warm months and warming in cold months (wind break effects).

Worksheet

Urban Forest Protection		MMTCO2e	MMTCO2e
Yard Tree Savings Program			
Number of trees over 15 years	15,000		
1000 Douglas Fir Trees Avg Age 57.5 MTC	1.2258		
1000 Douglas Fir Trees Avg Age 67.5 MTC	1.7252	0.0000	0.0000
MMTCO2 biomass removed (15 yr)	0.07		
MMTCO2 Products in use - storage (yr 7.5)		0.0007	0.0003
MMTCO2 Landfill - storage (yr 7.5)		0.0004	0.0005
MMTCO2 Biomass energy - annual emission		-0.0013	-0.0014
Mbtus biomass energy (17.0 Mbtus per dry ton)	281,436		
Mwh biomass energy (11550 btu per Kwh)	24,367		
MMTCO2 displaced (950 lbs CO2 per Mwh) annual	0.011	0.0007	0.0007
MMTCO2 Other WP - emission (yr 7.5)		-0.0008	-0.0011
MMTCO2 Forest Sequestration (stand replacement) (yr 7.5)		0.0000	0.0000
MMTCO2 from logging residue		-0.0002	-0.0009
MMTCO2 from building materials substitution		0.0004	0.0004

Total Net Annual GHG Savings/Loss MMTCO2 from Harvest		-0.0001	-0.0014
Avoided Loss from Harvest + Gain from 10 yrs Growth		**0.0001**	**0.0014**
Street Tree Establishment Program			
Number of trees over 15 years	15000		
Douglas Fir Trees Avg Age 5 MTC	0.01362		
Douglas Fir Trees Avg Age 12.5 MTC	0.05448		
Douglas Fir Trees Avg Age 57.5 MTC	1.2258		
Average annual savings MMTC		0.0001	0.0012
Forest Canopy Restoration Program			
Current Acreage and Stand Specifications	TBD		
Target Acreage and Stand Specifications	TBD		
Calculated Savings	TBD		

Key Uncertainties:

- Baselines for trees and forestland in the Puget Sound region
- Cooling and heating effects
- Program options
- Costs

W2. Convert Landfill CH4 to Energy

POLICY/PROGRAM DESCRIPTION: Methane has a high global warming effect per ton relative to carbon dioxide. It is a significant waste byproduct of land filling operations that result in anaerobic decay of organic waste. In some cases methane from landfills is flared to waste heat and carbon dioxide (with a lower global warming effect), or captured and converted to direct heat use or electricity production. When methane is converted to energy it may displace higher emissions energy supplies (typically fossil fuels) and have a significant offset effect. Waste to energy conversion of landfill methane is equipment intensive and requires access to energy markets, either on site or through the electricity grid. Programs that increase methane conversion to energy often rely on financial incentives, market development, or consolidation of waste methane for economies of scale.

The work group recommended evaluating methane recapture for energy use at plants that are closed but not decommissioned in addition to operating plants with known capacity for methane recapture. All large plants in the region flare gas, at a minimum, so the benefits of flaring are not considered.

KEY RESULTS: Carbon dioxide and methane gas reduction from capture of methane gas for energy or flaring, with potential displacement of higher emissions energy alternatives.

Worksheet

Plant - Existing	**Potential aMW**	**$/Kwh**	**PS?**	**$Kwh**
Hidden Valley	1.70		y	0
Northside	0.80			
Roosevelt Regional	9.50			
Tacoma	1.70		y	0
Plant - Potential				
Cedar Hills	22.50	0.0299	y	$197,100,000
Roosevelt Regional	10.50	0.0299		$91,980,000
Cathcart	2.60	0.0440	y	$22,776,000
Cheyne Road	0.00	0.0440		$0
Greater Wenatchee	0.00	0.0440		$0
Kent Highlands	22.50	0.0353	y	$197,100,000
Leichner	0.90	0.0440		$7,884,000
Terrace Heights	0.00	0.0440		$0
Total Statewide Landfill CH4	72.70			
Total New Puget Sound Landfill CH4	28.50			

Puget Sound Landfill Methane Recapture

PS Kwh (annual)	249,660,000
PS Mwh	249,660
PS aMw	28.50

Displaced Electric Power	
Marginal Displacement of NG	
MTCO2e	108,714
kMTCO2e	**108.71**
$/MTCO2e	

Direct CH4 reduction (Elec Supply)	
MTCO2e	0
kMTCO2s	0.00
$/MTCO2e	

Displaced + Direct CH4	
MMTCO2e	0.11
$/MTCO2e	

Data Sources, Methods and Assumptions:

- Data sources from the NW Energy Coalition, Tellus Institute Study available at: http://www.nwenergy.org/outreach/tellus_report.html.
- Power emissions offsets use natural gas load factors of 0.48 tons CO2 per Mwh
- No new price subsidies assumed
- Midway and other closed but not decommissioned plants not added
- All reductions assumed to be above baseline
- Static analysis; no market shifts in prices

Key Uncertainties:

- Cost effectiveness of power generation
- Baseline levels of methane capture and conversion expected under "business as usual"
- Impact of Midway plant and others closed but not decommissioned
- Impact of statewide plants
- Impact of new technologies

APPENDIX M – Additional Strategies for Consideration

The CPAC identified the following strategies as additional GHG strategies for consideration. These strategies were not technically analyzed in the CPAC process.

Buildings/Facilities and Electricity Supply Sectors
(With respect to the energy efficiency strategies, a *number of parties in the region, notably the NPPC, have examined the magnitude and source of cost-effective energy efficiency resources. The following list of efficiency actions represent a number of measures and programmatic approaches that could be implemented to capture efficiencies. The list is not prioritized or as in-depth as the NPPC's analysis in its 5th Power Plan.)*

1. Tax and non-tax credits and incentives for renewable energy could be directed to specific application such as solar photovoltaic systems, as recently proposed to the WA legislature

2. Utility-wide generation performance standards could be considered as part of a cap and trade system described above, especially to limit purchases of higher emissions electricity from out-of-state region sources

3. GHG mitigation requirements for EXISTING power plants, is similar but more limited in scope than a cap and trade program.

4. GHG mitigation requirements for NEW power plants, Washington's Department of Ecology recently proposed rules for the offset/mitigation of CO_2 emissions from fossil fuel burning plants that are between 25-350MW. The CPAC recognized the importance of these kinds of measures, but considered this a lower priority as legislation in this area had already been passed. However, efforts such as Ecology's, aimed at clarifying and strengthening this legislation, still needs support from the region in order to ensure the benefits of the legislation are realized.

5. Load management, pricing and metering strategies such as time of use rates.

6. Transmission and distribution line loss reduction is being pursued by some utilities and may be investigated further.

7. Sulfur hexafluoride (SF6) management programs would aim to limit the losses of this highly potent heat-trapping gas used for transformer and other utility applications.

8. Efficiency improvements and repowering existing plants, as an important long-term strategy, especially relevant for hydroelectric facilities.

9. Natural gas leakage reduction programs, can reduce fugitive methane emissions from pipelines and storage facilities

10. Mandatory or voluntary reporting of fuel use, GHG emissions as a CPAC-wide strategy.

11. Incentives for renewable energy applications, such as solar photovoltaic systems, solar water heaters, and other buildings and facility applications may be considered

12. Encourage green power purchases, at retail level. May be folded into a broader education strategy.

13. Bulk purchasing programs for housing developments would acquire higher efficiency appliances. Could be included in an overall education strategy.

14. Building commissioning, a process to ensure that new construction achieves its full design characteristics, should be reconsidered if not adequately covered through building code, code enforcement and other measures.

15. Industrial ecology/by-product synergy, otherwise referred to as cleaner production systems

Transportation Sector

16. Low GHG Fleet Vehicles, would focus on providing incentives and initiatives to encourage public and private owners of vehicle fleets to purchase low-GHG vehicles. This approach could represent a good opportunity for government to lead by example and achieve economies of scale, while also reducing VMT.

17. Operator/Maintenance Incentives, would combine incentives to improve maintenance of vehicles and an education program to inform vehicle operators and owners.

18. Research, development and demonstration, in particular, support state partnering with private industry and others to explore conversion to cellulosic ethanol.

19. Complementary Infrastructure Measures, such as ramp metering, should be considered to determine their potential collective impact.

20. Auxiliary power units: this approach would focus on decreasing emissions from aircraft engines through strategies such as at-gate plug-in technology.

Forestry, Agriculture and Solid Waste Sectors

21. Develop carbon offsets (and credit potential) for sale of agriculture, forestry and waste options in the Puget Sound region to stimulate markets for mitigation actions and encourage expanded levels of effort under greenhouse gas plans by providing flexibility mechanisms.

22. State procurement of locally grown wood products to reduce CO2 transport emissions associated with long distance haul of products. The supply of biomass for local wood products is part of the broader forest management option, and could be combined with a program to support use of sustainably grown local wood products.

23. Improve efficiency of wood burning stoves, or fuel switching**,** to maximize benefits of displacing higher CO2 emitting energy supplies such as gas, oil, or coal. Support continuing work of the Clean Air Agency.

APPENDIX N –Suggested Education Actions

As incorporated in the draft report, the CPAC recommends developing a two-part education strategy. The first part of the education strategy is a broad-based education and outreach campaign; the second part tailors key messages and lessons for specific audiences. The CPAC recommends building the broad-based campaign around outreach efforts designed to educate citizens about the potential impacts of global climate change on everyday lives, the benefits of climate solutions, and steps citizens can take to live GHG-friendly lives.

The second part of the education strategy should target changes in the behaviors of key audiences (e.g., local government officials and planners, utility operators, developers, architects, foresters, farmers, park managers, and/or small business owners). Important messages should highlight the economic as well as environmental benefits of changing behavior as well as potential economic development opportunities.

Following are suggested education actions, by sector, under each of the two categories described above:

Transportation

<u>Broad-based Education/Outreach:</u>

Public:

- Make clear and explain connection between motor vehicle emissions and climate change.
- Educate on the impacts of driving, in particular single-driver trips, including air quality, health, economic, etc. impacts.
    - Target first time drivers so they understand full implications of driving (e.g., driver's educations)
    - Examine City of Seattle's One Less Car Campaign results
- Educate on the impacts of decisions regarding residential choices—where we live and how we live
- Educate on the availability of choices and what those choices are, such as bike paths, buses, vanpools, car-sharing, etc.
- Educate on how individual choices can have a positive impact—what modes of transport we use, when we drive, how we drive, etc.
    - Link to driver training/vehicle maintenance
- Educate employers regarding flex-time, providing commuter choices, working at home, etc.

Government:

- Identify successful education programs and work to expand their message to include climate change where appropriate
- Assess the impacts of climate change on the four counties and Washington (e.g., Economic impact of loss of snow pack—salmon, agriculture, ski industry, hydropower, etc.)

<u>Key Messages:</u>

Targets specific messages to stakeholder groups/sectors on ways they can provide and incorporate better transportation options (e.g., technology and structural options), benefit from this improvement, and how this improvement might contribute to efforts toward reducing global warming/ climate change. The following is a list of stakeholders/sectors and specific educations strategies per stakeholders group/sector.

Trucking, Cargo, and Shipping Companies; Airports; Ports; Ferries; and Local government

- Educate on general maintenance and operation of vehicles, including proper tire inflation, tune-ups, alignments, air conditioning maintenance and the importance of following speed limits, idling, and availability of tools/information sources regarding congestion, etc.
- Educate on off-road technology, structural, and alternative fuel options and impacts, specifically:
    - Technology options—emphasize availability and impact of more efficient vehicles and technology
        - Operational efficiencies—computer management of containers and trucks on terminals to shorten idling and length of trips
        - Maintenance efficiencies—adding on new efficient technologies
    - Structural options: emphasize impact of more efficient movement of cargo and use less fuel
    - Alternative fuels: emphasize availability and impact of alternative fuel usage

Local Government and Businesses:

- Educate on impacts of fleet selection, information on more efficient on-road vehicles and other fleet options, and economic and environmental benefits of these options.
- Provide centrally located expertise that can travel to local jurisdiction and discuss land use planning, basics of GMA, etc.
- Recommend a study to inventory parking spots in the State.

Transportation planners and commissioners and Property Developers (including government property):

- Educate on better transportation design/planning options (e.g., sidewalks, bike paths, distance from transit, etc.)
- Per property developers, educate on benefits and minimizing impacts of using local materials

Rental Companies:

- Educate on the availability of technology and alternative fuels
- Educate on general maintenance and operation of vehicles, including proper tire inflation, tune-ups, alignments, air conditioning maintenance and the importance of following speed limits, idling, and availability of tools/information sources regarding congestion, etc.

Electricity Supply

l

Broad-based Education/Outreach:

Consumers:

- Educate consumers regarding purchasing, use of energy and conservation, and energy source choices/options. Consumers should understand the impact of purchasing energy/resource mix
    - Apply line item in utility bills identifying carbon footprint for individuals, households, business, etc.
    - Emphasize link to fossil fuels and costs of depending on these energy sources.
- Consumers should be made aware of areas of potential energy savings throughout their homes and of long-term savings/benefits associated with additional charges/costs
    - Educate on the cost of doing nothing (note this requires a statewide study to identify the economic and environmental impacts potentially caused by climate change)
- Educate consumers regarding green power alternatives (overlap with buildings and facilities)
- Educate consumers/public on energy conservation/efficiency programs to gain more support and influence legislators.
- Develop specific programs for K-12 curriculum regarding renewable sources of energy, energy efficiency, and the impacts of decisions

Key Messages:

Regulatory Community/Legislators and Utilities

- Educate legislators on the economic and environmental costs/impacts and carbon-related risks (highlight financial risks) due to climate change and how policy promoting sustainable energy sources and efficiency can help minimize impacts.
    - For example, benefits of Cap and Trade programs
- Education local government regarding impacts of methane

Utilities

- Educate hydro utilities and suppliers regarding the risks/impacts associated with climate change
- Educate utilities regarding long-term impact of climate change and impact of short-term actions.
- Understand impacts of doing nothing, particularly on hydropower supply

Buildings/Facilities

Broad-based Education/Outreach:

- *Consumers*:
    - Educate consumers regarding purchasing and use of energy efficient devices. Consumers should understand the impact of purchasing energy efficient devices – environmental and economic and know the availability of these devices.

- Consumers should be made aware of areas of potential energy savings throughout their homes, including building design, envelope, and internal
- Educate consumers regarding green power alternatives (overlap with energy supply)
- Educate consumers regarding fuel choices/fuel conversion options, including retrofit/upgrade of existing heating systems and water heaters. *(Note High Interest strategy BF7a – Residential Fuel Conversion)*

<u>Key Messages:</u>

Retailers

- Educate retailers regarding energy saving devices and appliances.

- *Developers/Contractors*
  - Educate developers and contractors regarding the energy code requirements
  - Train developers/contractors/planners/architects on low GHG design/sustainable building.

- *Building Operators/Contractors*
  - Educate/train commercial building operators regarding equipment maintenance, energy efficient devices/options. For example, Northwest Energy Efficiency Alliance's Building Operator Certification. *(Note High Interest strategy BF12 – Training of commercial building operators)*
  - Educate contractors regarding use of cement substitutes
  - Educate contractors regarding energy efficiency in new and existing construction

- *Business/Industry—Small, Medium, and Large*

  Messages should be targeted specifically for small, medium, and large businesses/industries.
  - Energy efficiency education for small and medium enterprises with a strong focus on economic drivers
  - Industrial energy management training *(Note High Interest strategy BF16 – Industrial Management Training)*

- *Government*
  - Use government efficiency goals and reporting for new buildings as an education and demonstration tool. For example, Seattle City Light's Sustainable Building Advisor Certificate Program. *(Note High Interest strategy BF17 – Energy efficiency improvements and Deserves Further Consideration strategy – Government efficiency goals and reporting)*
  - Educate local housing agencies regarding bulk purchasing of energy efficient appliances for low-income housing and mobile home parks *(Note Deserves Further Consideration strategy – Bulk Purchasing Programs)*
  - Educate municipalities regarding building code and building code enforcement *(Note High Interest strategy BF6 – Building Code Changes, Training and Enforcement)*

Forestry, Agriculture and Solid Waste

Key Messages

Wastewater:

- *Establish a wastewater education program*.
  - Energy efficiency improvements of waste processing machinery and equipment to reduce CO_2 emissions from electricity and fuel use
  - Lower waste processing needs (water consumption, waste production) to reduce CO_2 emissions from electricity and fuel use
  - Methane (CH_4), biogas energy programs to convert CH_4 to electricity production and displace higher emissions energy supplies
  - Install digesters and turbines to convert waste CH_4 to electricity production and displace higher emissions energy supplies.

Agriculture:

- Educate consumers about preferred purchase of locally grown organic produce, et cetera.
- Encourage purchase of locally grown agricultural products to reduce CO_2 emissions from long-distance transport of produce.
- Education farmers, conservation districts and cooperative extension units regarding:
  - Reducing N_2O and CH_4 emissions from treatment and application of manure and fertilizer
  - Expanding organic farming to reduce emissions of CO_2 and N_2O from fertilizer use and potentially CO_2 emissions from farm equipment use.
  - Conservation tillage/no-till to reduce loss of soil carbon and reduce CO_2 emissions from farm equipment use.
  - Increasing winter cover crops to increase carbon storage in soils.

- Educate homeowners, parks departments, landscape companies, etc regarding reducing non-farm fertilizer use on suburban and urban landscapes to reduce N_2O emissions and potentially CO_2 from lawn care equipment.

Forestry

- Education and outreach to small timberlot owners regarding carbon storage potential of different tree species, good forest management techniques, and GHG-friendly options associated with the use/removal of forest biomass.
- Target developers and landowners in rural areas regarding carbon storage potential of forested lands and keeping lands forested, even during development. Subcomponents of this educational program may focus on cluster and other land development options that encourage greater retention of trees and minimal soil disturbance.
- Educate residents about the importance of maintaining healthy trees on their properties. While providing tips on how to keep yard trees healthy, the educational materials can emphasize the many values and "services" these trees provide (e.g., they store carbon (which reduce overall GHG emissions), provide shade (which can cut down on buildings' summer cooling costs), and block wind (which can contribute

to winter heating savings). Educating Parks Managers is also critical (much like with small timberlot owners, above).