Chapter 10: Climate Change Issues

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SUMMARY OF KEY FINDINGS

Climate change presents a daunting challenge for regional power planners. There are at least two ways in which climate can affect the power plan. First, warming trends will alter electricity demand and change precipitation patterns, river flows and hydroelectric generation. Second, policies enacted to reduce green house gases will affect future resource choices. There remains a great deal of uncertainty surrounding both of these issues. This chapter describes the second of these issues, namely how current policies affect the plan's resource strategy and what future policies may help achieve green house gas emission reduction goals. The first issue, relating to physical changes resulting from climate change is discussed in Appendix L.

The focus of climate policy especially for the power generation sector will be on carbon dioxide emissions. Nationally, carbon dioxide accounts for 85 percent of greenhouse gas emissions, with about 38 percent originating from electricity generation. For the Pacific Northwest the power generation share is only 23 percent because of the hydroelectric system. Analysis by others has shown that substantial and inexpensive reductions in carbon emissions can come from more efficient buildings and vehicles. More expensive reductions can come from substituting non- or reduced-carbon electricity generation such as renewable resources and nuclear, or from sequestering carbon.

Reductions in carbon emissions can be encouraged through various policy approaches including, regulatory mandates (e.g. renewable portfolio standard or emission standards), emissions cap-and-trade systems, emissions taxation, and efficiency improvement programs. Policy responses to climate change concerns for the Northwest states have focused on renewable energy and new generation emission limits. National and west-wide proposals have focused on cap-and-trade systems, although none have been implemented successfully. Although carbon taxes are easier to implement than cap-and-trade systems, none have been proposed.

The Council's "$0 to $100 per ton carbon penalty" scenario assumes current climate policies that include renewable portfolio standards (RPS), new generation emissions standards and renewable energy credits. The scenario also assumes various future carbon penalty cost trajectories that vary between zero and $100 per ton and average $47 per ton by 2030. The least risk resource portfolio in this scenario includes a combination of conservation, renewable resources and gas-fired resources and results in a reduction of power system carbon emissions from 57 million tons per year in 2005 to an average of 37 million tons in 2030. This expected reduction, which is below the 1990 emission level of 44 million tons, is generally consistent with targets adopted by Northwest states. This expected reduction is the average of 750 futures, which means that about half of all futures have greater reductions and about half have less reductions.

If no future carbon pricing policies are assumed, a least-cost resource strategy would only stabilize carbon emissions at about current levels. Therefore, relying only on existing policies will not achieve the WCI carbon emission goals or those of individual states in the region. To significantly lower carbon emissions, existing coal-fired generation must be reduced. In the $0 to $100 per ton carbon penalty scenario, these plants are simply used much less frequently because of cost. However, there are potential future conditions where coal generation would be needed. In order to ensure a reduction in emissions, coal plants must be retired. Analysis of a scenario in which all regional coal plants are phased out between 2012 and 2020 showed that carbon emissions could be reduced to about 15 million tons by 2030. A number of alternative scenarios were analyzed to investigate the relationship between future carbon cost levels and emissions.

The Columbia River hydroelectric system provides most of the region's energy, capacity, and flexibility supply. As a carbon free resource, it is extremely valuable to the region. Primarily because of the hydroelectric system the region's carbon emissions are half of those for the nation as a whole. Meeting the region's responsibilities for mitigating the fish and wildlife losses caused by the dams has depleted the capabilities of the hydroelectric system over time. The region should carefully consider future fish and wildlife operations because loss of hydroelectric capability will increase carbon emissions. For example, removing the lower Snake River dams would undo 40 percent of the carbon reductions expected to be accomplished through the Council's plan.

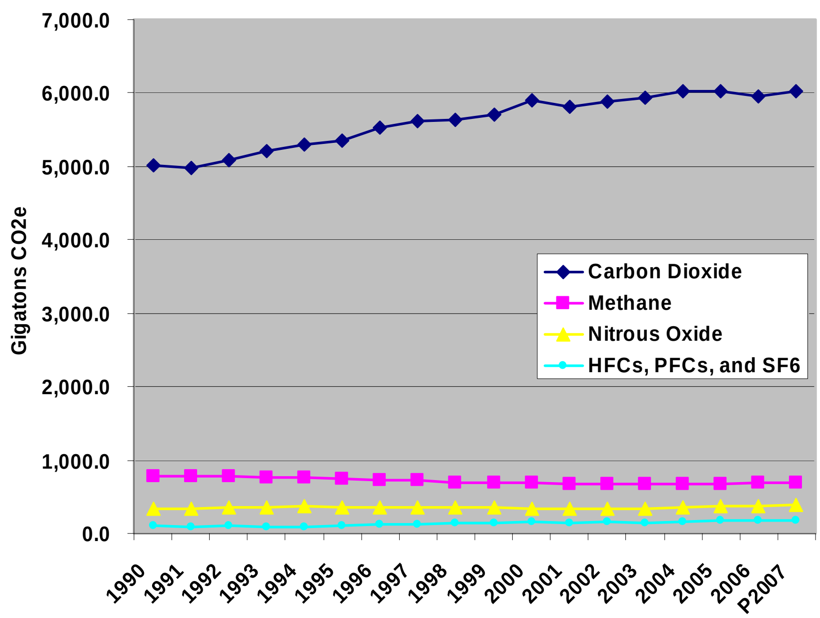
BACKGROUND

A large uncertainty facing future plans for electricity generation and use is climate change and associated policies aimed at controlling greenhouse gas (GHG) emissions. This chapter focuses on sources of GHGs related to the production and consumption of energy, especially the burning of fossil fuels, which are the focus of these policies. It does not address the phenomenon of climate change or its likely effects, but rather on how concerns and policies about those affect the region's energy system planning. Appendix L examines the physical implications of some specific climate change scenarios on the region's power system.

Greenhouse gases include a family of gases that affect the ability of the earth's atmosphere to absorb or reflect heat.[1] These include carbon dioxide, methane, nitrous oxide, and man-made CFC refrigerants. Different gases have different degrees of effect on warming and these are measured as global warming potential (GWP). Carbon dioxide, which has become almost synonymous with GHG, has the least global warming potential of the GHGs. Many of the other GHGs have global warming potentials thousands of times greater than that of carbon dioxide. Nevertheless carbon dioxide has become the primary focus of climate policy and discussion. The reason is that carbon dioxide accounts for more than three quarters of global GHG emissions. In the U.S. carbon accounts for 85 percent of GHG emissions and it is a growing source. Figure 10-1 shows that growth in carbon dioxide emissions are the primary reason for total U.S. GHG emissions growing since 1990. Levels of emissions from most other GHGs have been stable or declining. Even carbon dioxide emissions, although growing in total, have declined relative to population and gross domestic product growth in the United States.

Declining carbon dioxide emissions per dollar of gross domestic product have been due to a changing mix of economic activity and improved efficiency of energy use. The combustion of fossil fuels accounts for 94 percent of U.S. carbon dioxide emissions. Therefore declining carbon dioxide emissions reflect a corresponding decline in energy use per dollar of gross domestic product.

Figure 10-1: Sources of U.S. Greenhouse Gas Emissions, 1990 to 2007



Source: U.S. Energy Information Administration

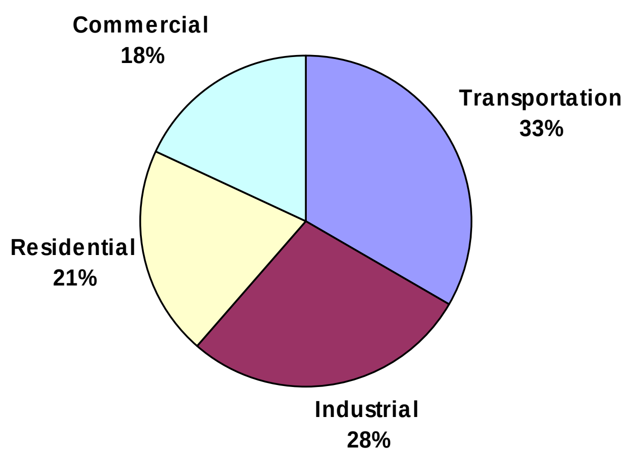
[1] The source of information for much of the following discussion is from the Environmental Protection Administration. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006. April, 2008. USEPA #430-R-08-005. http://www.epa.gov/climatechange/emissions/usinventoryreport.html

The National View

For the United States as a whole, electricity generation is the largest source of carbon dioxide emissions. Electricity generation accounted for 34 percent of carbon dioxide emissions in 2006. The next largest emissions sector was transportation at 28 percent, followed by the industrial sector at 20 percent. Other significant sectors include agriculture, residential and commercial. However, electricity is generated to be used in other sectors. When the carbon dioxide emissions from electricity generation are allocated to the sectors using the electricity, and added to those sectors' direct combustion of fossil fuels, a different mix of emissions sources results. In that accounting framework, which relates carbon emissions to the underlying human activities, transportation becomes the largest carbon dioxide emitting sector. Figure 10-2 shows the sources of carbon dioxide emission by end use sector in the U.S.

For electricity planning, the implication of this information is that, to reduce carbon dioxide emissions from the electricity sector, policies should address both the generation of electricity and the efficiency of electricity use. Carbon emissions from electricity generation can be addressed through improved efficiency of generation and transmission technologies, changing the mix of generation from coal to natural gas, substituting renewable non-carbon-emitting sources of generation, or various strategies to sequester the carbon dioxide emissions. On the electricity use side, improved efficiency of use reduces the need to generate electricity. Policies should target both sides of the electricity equation with priority given to the lowest cost mitigation approaches. Further, policies should also address emissions from the direct use of fossil fuels in other sectors, including transportation.

Figure 10-2: Carbon Dioxide Emissions by Sector, 2006

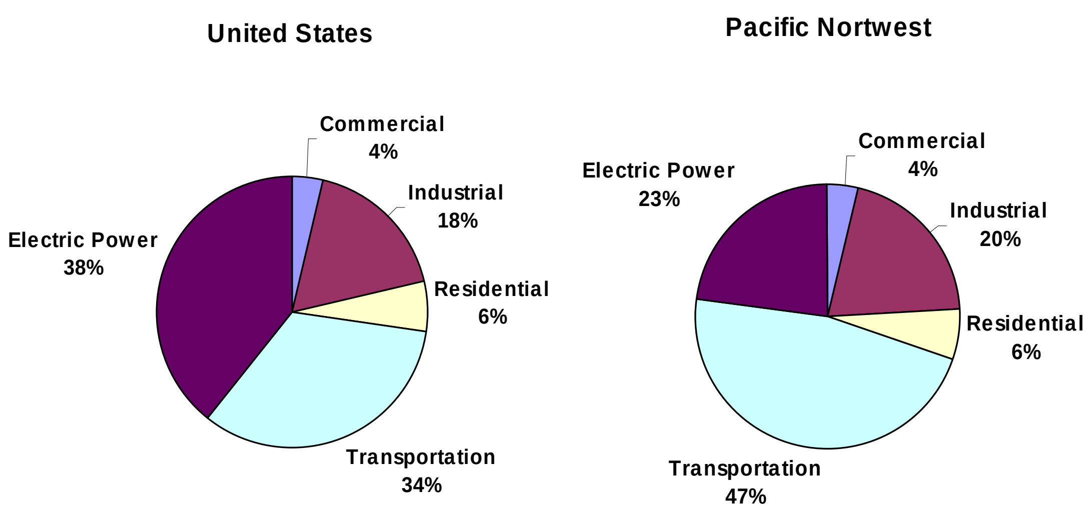


Note: Electricity generation emissions allocated to end use sectors
Source: U.S. Environmental Protection Agency

The Pacific Northwest Regional View

The sources of carbon emissions in the Pacific Northwest are not typical of the U.S. as a whole. Figure 10-3 compares the shares of carbon dioxide emissions from economic sectors for the U.S. and the 4 states in the Northwest. Unlike Figure 10-2, emissions from electricity generation are included in the electric power sector in Figure 10-3. In the Pacific Northwest, the share of energy related carbon dioxide emissions from electric power generation is much smaller than for the U.S. For the U.S. electric power is the largest source of carbon dioxide, but in the Pacific Northwest transportation is the largest. The reason, of course, is the dominance of the hydroelectric system in Northwest electricity supply.

Figure 10-3: Energy Carbon Emissions by Sector, 2005

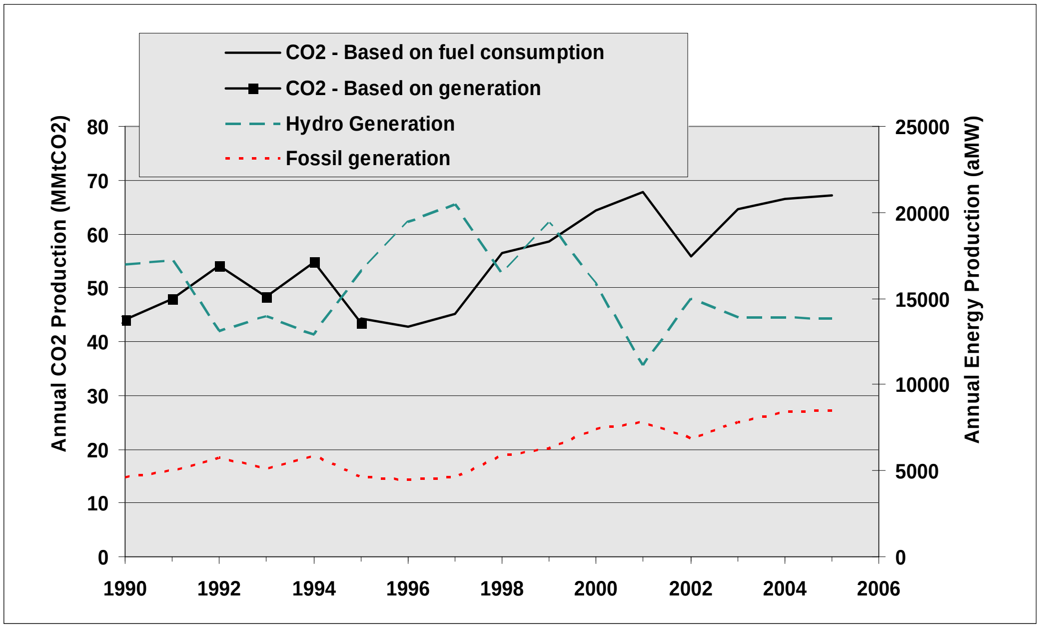


The years 1990 and 2005 are frequently used as benchmarks in policies for the control of greenhouse gasses.[2] The 1990 production of carbon dioxide from the Pacific Northwest power system is estimated to have been about 44 million tons, based on electricity production records of that year. Load growth, the addition of fossil-fuel generating units, the loss of hydropower production capability, and the retirement of the Trojan nuclear plant resulted in growing CO_2 production over the next 15 years. By 2005, the most recent year for which electricity production or fuel consumption data are available, CO_2 production increased 52 percent to 67 million tons (Figure 10-4). This is approximately the CO_2 output of 23 400-megawatt conventional coal-fired power plants, 56 400-megawatt gas-fired combined-cycle plants or about 11.7 million average U.S. passenger vehicles.

[2] For example, California Assembly Bill (AB) 32, passed by the legislature and signed by the governor in 2006, calls for enforceable emission limits to achieve a reduction in CO_2 emissions to the 1990 rate by 2020. Washington Governor Gregoire's climate-change executive order includes the same target for CO_2 reductions. Oregon House Bill 3543, passed by the legislature and signed by Governor Kulongoski in August, declares that it is state policy to stabilize CO_2 emissions by 2010, reduce them 10 percent below 1990 levels by 2020, and 75 percent below 1990 levels by 2050. The goal of the Western Climate Initiative is to reduce GHG emissions to 15 percent below 2005 levels by 2020.

The regional CO_2 production estimates from 1995 through 2005 shown in Figure 10-4 are based on the fuel consumption of Northwest power plants as reported to the Energy Information Administration (EIA). Because fuel consumption data were not available before 1995, estimates for 1990 through 1995 are based on plant electrical output as reported to EIA and staff assumptions regarding plant heat rate and fuel type. Estimates based on plant electrical production are likely somewhat less accurate than estimates based on fuel consumption because of multi-fuel plants and uncertainties regarding plant heat rates. However, the two series of estimates are within 2 percent in the "overlap" year of 1995.

Figure 10-4: Growth of CO_2 Emissions from Electricity Generation in the Pacific Northwest



Annual hydropower conditions can greatly affect power system CO_2 production. Average hydropower production in the Northwest is about 16,400 average megawatts. As shown by the plot of Northwest hydropower production in Figure 10-4, the 1990 water year was nearly 17,000 average megawatts, slightly better than average. Other factors being equal, this would have slightly reduced CO_2 production that year by curtailing thermal plant operation. Conversely, hydro production in 2005 was about 13,800 average megawatts, a poor water year. Other factors being equal, this would have increased thermal plant dispatch, raising CO_2 production. The effect of hydropower generation on thermal plant generation and CO_2 production is apparent in Figure 10-4.[3]

If normalized to average hydropower conditions, actual generating capacity, and the medium case loads and fuel prices of the Fifth Power Plan, the estimated CO_2 production in 2005 would have been 57 million tons, a 29 percent increase over the 1990 rate. This is the value used for comparison in this paper.

[3] In Figure 10-4, it is evident that Northwest thermal generation does not decline as much as Northwest hydro generation increases in above average water years, e.g. 1994 - 1997. This is likely due to the fact that the abundant hydropower of good water years creates a regional energy surplus that can be sold out of the region where it displaces thermal generation, which often consists of older, less efficient gas-fired units.

ACTIONS TO REDUCE GREENHOUSE GAS EMISSIONS

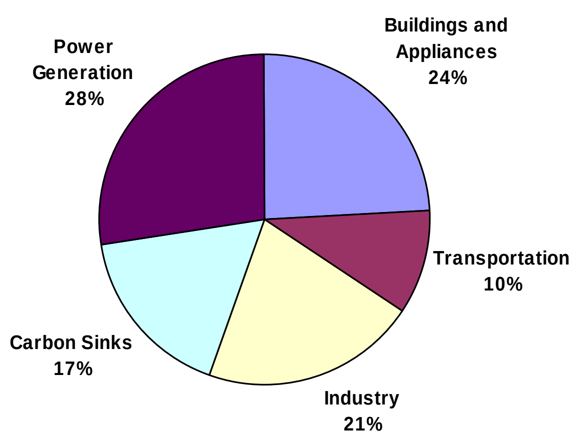
Because GHG emissions are dominated by carbon dioxide emissions from burning fossil fuels, and that is the primarily source of emission from electricity generation, the focus in this section is on carbon dioxide emissions. From a broad perspective, there are three general kinds of actions that can be taken to reduce carbon dioxide emissions; electricity could be generated from lower or zero carbon emitting fuels, the use of electricity could be reduced, or carbon that is released could be sequestered or offset. Similar possibilities exist for other uses of energy from fossil fuels besides electricity generation.

In 2007, McKinsey and Company undertook a study of how much GHG reduction was possible in the U.S. and what it might cost.[4] The McKinsey report looked at alternative actions to reduce GHG emissions. They assumed that without actions GHG emissions would grow from 7.2 billion metric tons to 9.7 billion metric tons by 2030. They then analyzed ways to reduce 2030 emissions by 3.0 billion metric tons, which was characterized as the mid-range of reductions sought in proposed legislation.

They estimated that about 40 percent of the reduction could be done at negative cost. Nearly all of this came from improved efficiency of energy use in buildings or vehicles. The remaining 60 percent of GHG reduction came from an array of actions that increased in cost as reductions grew. The most expensive option used to achieve the 3.0 billion metric ton reduction of 2030 emissions was estimated to cost $60 per ton.

All of the actions included in the McKinsey analysis were placed into five categories; buildings and appliances, transportation, industry, carbon sinks (or sequestration), and power generation. In the case where carbon emissions were reduced by 3.0 billion tons, the sources of reductions are shown in Figure 10-5. As was the case for Figure 10-2 emissions reductions from more efficient use of electricity are counted in the sector where electricity is consumed.

Figure 10-5: Estimated Sources for a 3 Billion Ton Reduction of GHG Emissions by 2030



[4] McKinsey & Company. Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? U.S. Greenhouse Gas Abatement Mapping Initiative, Executive Report. December 2007.

There are some interesting observations to make about the McKinsey results. Although a great deal of the policy discussion on GHG reduction centers on the electricity generation sector, only a quarter of the actions identified in the McKinsey report are electricity generation changes. Further, the electricity generation changes are among the more expensive actions, and they include actions such as renewable generation and carbon capture and sequestration, which cannot be implemented easily in the near term.

Another focus of policy speculation and potential is hybrid vehicles. In the McKinsey analysis, it is the most expensive alternative shown (around $90/ton) and it has relatively small potential for GHG reduction. The plug-in hybrid option was not needed to reach the 3.0 billion ton reduction case described above. Improved efficiency of conventional vehicles has far greater and cheaper potential.

If the goal is to stabilize GHG concentrations in the atmosphere, and if the climate change science is correct, policy decisions would not be a question of which mitigation strategies to pursue, but rather how to pursue all possible actions. The reductions in emissions that the McKinsey report addressed were for recent GHG policy proposals, but they do not reach the reduction levels needed to stabilize warming trends identified by climate scientists. For example, the Intergovernmental Panel on Climate Change estimated that emissions of GHG would need to be reduced to about one quarter of today's emissions by 2100 to stabilize atmospheric concentrations of GHG.

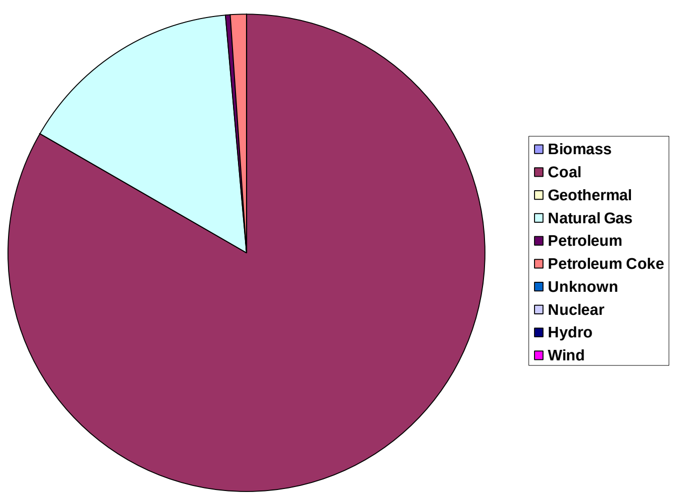
There have been many studies of the costs of particular policies or goals for GHG reduction. The usual purpose has been to try to estimate the price of carbon that is likely to be associated with a policy. The Council had a study done by EcoSecurities Consulting Limited to provide a range of likely carbon costs during the period of the Council's power plan. EcoSecurities reviewed many studies and provided a set of alternative estimates of carbon prices based on their models of supply curves for carbon mitigation actions. Point Carbon reviewed the results of 7 studies of the Lieberman-Warner bill for Bonneville, and used the studies to estimate a reasonable range of expected carbon prices under the proposed cap-and-trade policy.

Carbon price estimates under cap-and-trade programs are very sensitive to different assumptions about such things as the level of the carbon emissions cap, the use of offsets, banking and borrowing provisions, and the geographic scope of trading assumed. Price forecasts for the 2025 to 2030 time period varied from near zero to well over $100 per ton of carbon emissions. However, the more plausible range of prices was from roughly $10 to $80. The EcoSecurties report estimated that carbon prices might need to reach about $50 a ton by 2030 to progress toward the Intergovernmental Panel of Climate Change goal of stabilizing GHG concentrations by 2100. Point Carbon's assessment suggested that prices would escalate rapidly in years beyond 2030 although they regard their forecasts that far into the future as highly speculative and unlikely to consider technological developments that may occur.

For the Sixth Power Plan the Council considered a range of possible carbon costs between zero and about $100 per ton, with an average cost of about $47 per ton by the end of the study horizon. This possible but uncertain cost of carbon emissions has a significant influence on the plan's resource strategy. Conservation, renewable generation, natural gas-fired generation, coal (with or without carbon sequestration), and advanced nuclear power all compete to provide the lowest cost and least risky resource portfolio. Even before accounting for the effects of uncertainty and risk on resource expected costs, it is clear that improved efficiency is available in significant amounts and at low cost without adding to carbon or fuel price risks for the region. Natural gas, wind (that can be developed without significant transmission expansion) and possibly some small quantities of other currently available renewable technologies are next most expensive. Many other renewable resources, coal with carbon separation and sequestration, and advanced nuclear may become available within the Council's planning horizon, but are not currently available or are very expensive.

To achieve very significant reductions in the regional power system's carbon emissions, simply reducing or stopping the growth of carbon emissions will not be enough. As shown in Figure 10-6, existing coal-fired power plants account for about 88 percent of the region's emissions. Therefore, for example, the region could not reduce its power system emissions below 1990 levels, as some targets suggest, if the region's coal plants continue to operate as they do now. Thus part of the solution to aggressive carbon emission reductions would have to include changing the role of existing coal-fired generation. This would occur as a matter of economics if carbon penalties are high enough and natural gas prices low enough. Natural gas-fired generation would begin to displace coal-fired generation in the dispatch order. In addition, some older coal-fired plants that face additional investment to extend their lives or meet more stringent environmental requirements may choose to close rather than face the uncertainty of unknown future carbon costs.

Figure 10-6: Sources of CO_2 Emissions from the Northwest Power System, 2005



POLICIES TO REDUCE GREENHOUSE GASES

There are many possible policy approaches to reduce carbon emissions. They include GHG cap-and-trade programs, direct taxation of GHG emissions, regulatory programs that limit emissions or require non-emitting resources to be developed, and efforts to improve the efficiency of energy use. Choices among these approaches have varied. Most recently proposed national legislation has focused on cap-and-trade programs, but none has been passed to date. At the regional and state level, renewable portfolio standards and limits on emissions of new power plants have been the focus of much policy. The Council has primarily focused on efficiency of electricity use, and states, utilities, and the Federal Government have initiatives in efficiency improvement as well. Most of these efficiency programs existed well before the climate change issue was prominent, simply because improved efficiency was cheaper than building new electric generating plants and it contributed to reduced oil imports. Each of these approaches has advantages and disadvantages.

Mandates

A number of mandates direct companies and individuals to acquire or produce energy-using equipment that meets an approved standard of energy efficiency, or uses approved types of energy. One example of such mandates is the Corporate Average Fuel Efficiency standard for cars and light trucks. It has been in place since 1975 and imposes fines on car manufacturers whose products don't meet the standard. Other examples are appliance efficiency standards and the region's building codes, which have had an energy-efficiency component for more than 20 years.

More recently Washington, Oregon, and Montana in the Pacific Northwest region and a number of states elsewhere in the country have passed laws (Renewable Portfolio Standards) that require utilities to increase the level of electricity generated by renewable resources. These or related laws have in some cases also required generators that use non-renewable fuels to meet maximum emissions per kilowatt-hour standards (e.g. Washington and California).

Mandates have the advantage of relative simplicity and are fairly simple to enforce. They have the disadvantage that they are inflexible in the face of changed technology or other conditions. For example, future reductions in emissions from a state renewable portfolio standard might well cost more per ton than subsidizing modernization of generation in China, or expanded forests in South America. But unless the mandate has been made sufficiently flexible, it would not recognize these new alternatives as satisfying the mandate.

Tax Incentives

Tax incentives may reduce the cost of investment in preferred equipment such as hybrid cars or energy-efficient equipment or equipment that captures renewable energy, by allowing accelerated depreciation, tax credits or various forms of tax exemptions. Tax incentives of these types have been extended to hybrid cars, electricity generators powered by wind, and energy-efficient equipment and structures, renewable energy equipment purchases and renewable energy equipment manufacturing facilities.

Tax incentives can also increase the value of output from preferred equipment such as wind-driven generators by granting tax credits (e.g. the production tax credit) based on the amount of electricity produced by the generators. Compared to investment tax credits, production credits have the advantage of rewarding the final product desired, so that producers are encouraged not only to invest in preferred equipment, but also to produce as much electricity as possible with it.

Cap-and-trade Programs

A cap-and-trade policy sets a cap on the total amount of emissions allowed in the covered territory. The cap is enforced by issuing allowances in the amount of the cap and then requiring emitters to surrender allowances in the amount of their emissions. The strategy is to reduce the amount of the cap and the equivalent allowances over time to reduce emissions. Emitters are allowed to trade allowances to encourage those who can reduce emissions easily and cheaply to do so and profit by selling their surplus allowances to other emitters. Emitters may be allowed to "bank" or "borrow" allowances from year to year if they have a surplus or deficit of allowances in a given year. Cap-and-trade programs may include provisions for offset allowance credits resulting from taking certain emission reduction actions outside the scope of the regulated system.

A cap-and-trade policy to control emissions of SO_2 and NO_X was established as part of the Clean Air Act Amendments of 1990. This policy is generally regarded as a success, resulting in faster reductions in SO_2 emissions at lower costs than anticipated. Cap-and-trade programs have been included in proposed federal legislation to control greenhouse gas emissions and are also included in Western Climate Initiative discussions. The European Union Emission Trading System has been in place since 2005, capping a substantial fraction of Europe's total greenhouse gas emissions, and providing experience with this policy approach.

Compared to mandates and tax incentives, a cap-and-trade policy has the advantage of flexibility. Emitters can pursue a variety of strategies to reduce their own emissions or they can pay other emitters to reduce. They can be expected to choose the strategy that will minimize their cost (and the societal cost) of compliance. Another advantage of cap-and-trade policy compared to mandates and tax policies is that the cost of emission allowances is incorporated into retail prices of energy, providing appropriate price signals to final consumers of energy or of products produced using energy.

As a policy with the goal of reducing emissions of greenhouse gasses, cap-and-trade programs make the physical target for emissions explicit. As a result, the policy should meet the target reliably, but emission prices and total costs of emission reductions could be volatile and hard to predict. In contrast, the carbon tax policy, described next, has a more predictable total cost, but a less predictable total reduction in emissions.

Finally, cap-and-trade programs require the development of a market to trade emission allowances. The market mechanism offers the potential for emission reductions at low costs, but the development of a market trading newly-created assets like emission allowances requires careful consideration to have confidence that the market will function as expected.

Carbon Taxes

A carbon tax would likely apply not only to carbon, but also to all greenhouse gasses in proportion to their climate-changing effects. The climate impacts of the non-CO_2 gases are generally expressed as "CO_2 equivalents," so for this discussion all such taxes will be referred to as a carbon tax. It would tax emissions of greenhouse gasses at a level that would be expected to reduce emissions to the level chosen to control and mitigate climate change.

At the margin, the effect on overall emissions of a carbon tax of a certain cost per ton of carbon equivalent emitted should be the same as a cap-and-trade policy that results in an allowance price of the same cost per ton of carbon equivalent emitted. But as was pointed out above, the tax makes the total cost of emissions reduction reasonably predictable while leaving total reductions unpredictable, while a cap-and-trade program makes reductions more predictable and leaves the total cost less predictable.

As a practical matter this distinction between a carbon tax and cap-and-trade program may be less than it seems. Given the current state of knowledge about the effects of climate change and the technological choices available for reducing emissions, it seems inevitable that whatever initial cap is chosen for the cap-and-trade program, or whatever initial level is chosen for a carbon tax, new information that becomes available over the next several decades will require adjustments in the national and global strategy to control greenhouse gasses.

CURRENT POLICIES AND GOALS AFFECTING THE PACIFIC NORTHWEST

At present, CO_2 reduction policies regionally, nationally and globally are still very much in a state of flux. CO_2 reduction goals range from stabilizing emissions at current levels to reducing emissions to 1990 levels or below. Many different policy initiatives and actions have been proposed (see above) to achieve these reduction goals. This section describes policies and actions that are currently being implemented on an international, federal and regional basis.

International Initiatives

Significant international initiatives targeted at climate change can probably be dated from 1992, when the U.N. Framework on Climate Change was negotiated. Since then there have been several significant milestones in international action, including the Berlin Mandate in 1995, calling for emission targets for developed countries and the Kyoto Protocol in 1997, which set targets for developed countries reductions by 2008-2012. The Kyoto Protocol, in spite of the withdrawal of the U.S. in 2001, has been ratified by 182 countries including 37 industrialized countries who account for over 60 percent of developed countries' emissions. It is hoped that a conference in Copenhagen in late 2009 will result in agreement on international action after 2012.

The European Union's Emissions Trading System has been functioning since 2005. It is a cap-and-trade system currently covering sources that are responsible for about half of the European Union's total carbon dioxide emissions. The system's first three years of operation (2005-2007) were intended to test the functioning of the market mechanism itself rather than to achieve significant carbon dioxide emission reductions. The system has experienced episodes of price volatility, which has been attributed to imperfect data and limited provision for banking emission allowances. Some electric power generators appear to have received windfall profits, which has focused attention on the regulatory treatment of those generators. The system will gradually expand to include emissions from more sources constituting a bigger share of total emissions over time.

The Intergovernmental Panel on Climate Change[5] has identified a goal of limiting global warming to 2 degree Celsius (3.6 degrees Fahrenheit) and has translated that goal into emission reduction targets for developed countries. Those targets call for an 80 to 95 percent reduction in emissions relative to 1990 levels by 2050.

[5] Information on the Intergovernmental Panel on Climate Change (IPCC) can be found at http://www.ipcc.ch/.

Federal Policies

The Waxman-Markey draft legislation, entitled "The American Clean Energy and Security Act of 2009," proposes a comprehensive strategy for energy planning and use. This legislation has four parts (or titles in legislative terms), which 1) promote clean energy production, 2) encourage energy efficiency, 3) reduce emission of greenhouse gases and 4) protect U.S. consumers and industry during the transition to a clean energy economy.[6]

Title I requires electricity suppliers to meet 6 percent of their load in 2012 and 25 percent of their load in 2025 with a combination of renewable resources and energy efficiency. It includes a carbon capture and sequestration (CCS) demonstration program, incentives for adoption of CCS, and performance standards for new coal-fired power plants. The title contains provisions to encourage the modernization and expansion of the electrical transmission system. Finally, it offers federal assistance to state clean energy and energy efficiency projects, and allows federal agencies to sign long-term contracts to buy electricity generated from renewable sources.

Title II includes a range of federal assistance measures to improve the energy efficiency of new and existing buildings. It strengthens efficiency standards for lighting and appliances, and improves the U.S. Department of Energy process for setting these standards in the future. It sets standards for electricity and natural gas distribution companies to help their customers accomplish energy efficiency. Finally, it calls for the establishment of standards for industrial energy efficiency, and extends eligibility for grants and loads for energy efficiency to nonprofit and public health hospitals.

Title III establishes a program that covers emitters responsible for about 85 percent of total U.S. greenhouse gas emissions. The program creates tradable allowances that must be surrendered for each ton of GHG emitted. The total amount of allowances is reduced over time so that aggregate emissions by the covered entities is reduced in stages to a level that is 83 percent lower than their 2005 levels by 2050. The title includes measures for the establishment and regulation of the market for trading allowances, and gives responsibility to the Federal Energy Regulatory Commission for regulating the cash market for allowances.

Title III directs the Environmental Protection Agency (EPA) to enter into agreements to reduce GHG concentrations by preventing international deforestation. The bill allows both domestic and international offsets not to exceed 2 billion tons yearly. The bill allows banking allowances to be used in later years, allows borrowing allowances that must be repaid the next year, and creates a strategic reserve of allowances to be used to limit market price volatility. Finally, the bill directs the EPA to set emission standards for sources not covered by the cap-and-trade program, and the bill creates special programs to reduce emissions of two pollutants that contribute to global warming: hydro fluorocarbons (HFCs) and black carbon.

Title IV is focused on the process of adjusting to a clean energy economy. It authorizes the Secretary of Education to award grants to colleges and universities to develop training programs to prepare students for careers in renewable energy, energy efficiency, and other climate change mitigation work. This section also establishes an interagency council to integrate federal

[6] Citation on internet for language of bill

response to the effects of global warming, and establishes an adaptation fund to provide support for state, local and tribal adaptation projects.

Regional Policies

The Western Climate Initiative (WCI) is a broad regional effort to implement policies to reduce greenhouse gas (GHG) emissions. The governors of Oregon, Washington, and Montana have joined governors from five other western states and the premiers of four Canadian provinces to collaborate on implementation of policies to address climate change. The overall goal of the WCI is to reduce the region's GHG emissions to 15 percent below 2005 levels by 2020. The primary policy objective of the WCI is implementation of an economy-wide regional cap-and-trade program.

The WCI Partners have promulgated specific design recommendations for the regional cap-and-trade program. In its first phase, beginning in 2012, the program would cover emissions from electricity production and from large industrial processes. The program would cover emissions of carbon dioxide and five other major greenhouse gases. In its second phase, beginning in 2015, the program would be expanded to cover emissions from the combustion of transportation fuels and from fuels burned at industrial, commercial, and residential buildings.

The process of developing the WCI has made it clear that a regional cap-and-trade program faces problems that are reduced if the program is made national or international. For example, individual states and provinces have significant flexibility to affect their jurisdiction's GHG reduction targets. The shares of the total reduction target that result are a source of potential conflict. Another example is the potential for "leakage," which can result from shifting emissions from inside the WCI to outside it. Such a shift would allow WCI emission targets to be met, but no net reduction in overall (global) emissions. Leakage becomes less likely as geographic scope of the cap-and-trade program increases to national or international.

State Policies

Policy initiatives at the state level to address climate change are numerous. This section narrows the focus to three types of state policy: GHG reductions goals; renewable portfolio standards; and emission performance standards. This selective summary misses a great deal of policy work aimed at establishing renewable energy tax credits, renewable energy feed-in tariffs, renewable energy enterprise zones, funding mechanisms for energy efficiency projects, improved commercial and residential building codes, and others that either directly or indirectly influence GHG production. The intent is to focus on policies that have the greatest relevance to the Sixth Power Plan.

Greenhouse Gas Emission Reduction Goals

The 2007 Oregon State Legislature set GHG emissions reduction goals for the state. The mid-term goal is to reduce emissions to 10 percent below 1990 levels by 2020. The long-term goal is a 75 percent reduction from 1990 levels by 2050. The 2009 Legislature is considering Senate Bill 80 which would authorize the state's participation in the WCI cap-and-trade program as a key means of reaching the future emission goals.

The 2009 Washington State Legislature is also considering WCI cap-and-trade legislation. House Bill 1819 and Senate Bill 5735 would codify the states goal of reducing greenhouse gas emissions to 1990 levels by 2020, achieving a 25 percent reduction by 2035, and a 50 percent reduction by 2050.

The Oregon and Washington emission reduction goals for 2020 have a direct bearing on the Sixth Power Plan. The Council's current modeling framework does not model each state separately, so its results can be interpreted as averages across the region as a whole. Analysis described later in this chapter examines the feasibility, cost, and best method of reducing Northwest power sector carbon dioxide emissions to 1990 levels by 2020.

Renewable Portfolio Standards

Renewable resource portfolio standards targeting the development of certain types and amounts of resources have been adopted by three of the four states in the region (Oregon, Montana, and Washington) since adoption of the Fifth Power Plan. Similar standards have also been adopted by Arizona, British Columbia, California, Colorado, New Mexico, and Nevada. The key characteristics of the Pacific Northwest state renewable targets are summarized in Table 10-1. The targets are subject to adjustments if costs increase above certain limits.

Table 10-1: Renewable portfolio standard targets

	Basic Standard
Montana	15% of IOU sales by 2015
Oregon	25% of sales by 2025 (large utilities) 10% of sales by 2025 (medium utilities) 5% of sales by 2025 (small utilities)
Washington	15% of sales 2020 + cost-effective conservation (utilities w/25,000 or more customers)

Carbon Dioxide Emission Performance Standards

Carbon dioxide emission performance standards have been adopted by California, Montana, Oregon and Washington. The Northwest state standards in effect at the time of draft plan release are as follows:

Montana: In May 2007, Governor Schweitzer of Montana signed into law HB 25, an electric power reregulation bill. Among various provisions, this bill prohibits the Public Service Commission from approving electric generating units constructed after January 1, 2007 and primarily fuelled by coal unless a minimum of 50% of the carbon dioxide produced by the facility is captured and sequestered. The requirement remains in effect until such time that uniform state or federal standards are adopted for the capture and sequestration of carbon dioxide. The bill further provides that an entity acquiring an equity interest or lease in a facility fueled primarily by natural or synthetic gas is required to secure cost-effective carbon offsets where cost-effective is defined as actions to offset carbon dioxide that do not increase the cost of electricity produced by more than 2.5%.

Oregon: Since 1997, the developers of new power plants in Oregon have had to offset their carbon dioxide emissions to a level 17% below best commercial generating technology of equivalent type. In July 2009, Governor Kulongoski signed into law SB 101 to establish a new greenhouse gas emission performance standard for all long-term procurements of electricity by electricity providers. The standard will be established by the State Department of Energy and will apply to all baseload electrical generating facilities. Baseload generating facilities are defined as facilities designed to produce electricity on a continuous basis at a 60% capacity factor or greater. The standard established by the State Department of Energy is to require that the greenhouse gas emissions of new baseload facilities be no greater than the rate of greenhouse gas emissions of a combined-cycle power plant fuelled by natural gas.

Washington: Since 2004, Washington has required fossil fuelled power plants subject to state site certification (generally plants of 350 MW, or greater) to offset or otherwise mitigate carbon dioxide emissions by 20%. Substitute Senate Bill 6001, signed into law by Governor Gregoire in May 2007 establishes a greenhouse gas performance standard for all "long-term financial commitments" for baseload generation used to serve load in Washington, entered into in July 2008, or later. The requirement applies whether the source is located within or without the state. Modeled on California Senate Bill 1368, the law defines baseload electrical generating facilities as facilities designed to produce electricity at a 60% capacity factor or greater. The law adopts the initial California limit of 1,100 lbs/CO_2 per MWh, and requires that the limit be reviewed and adjusted every five years by the Department of Community Trade and Economic Development to match the average rate of emissions of new natural gas combined-cycle power generation turbines. The limit is likely to be reduced on review since current natural gas combined cycle plants produce about 830 lb/CO_2 per MWh (the California limit appears to have been based on the carbon dioxide output of an aeroderivative simple-cycle gas turbine operating on natural gas, not a combined-cycle turbine). The law allows up to five years to provide carbon dioxide separation and sequestration as long as average lifetime emissions comply.

EVALUATION OF CARBON STRATEGIES

Existing climate change policies and proposed future policies have had a very significant effect on the development of the Sixth Power Plan resource strategy. In this section the effects of alternative policy assumptions are described. The intent is not to recommend any particular approach, but to provide information to policy makers about the likely effects of different approaches on the cost of the power system and its future carbon emissions.

The recommended actions in the Sixth Power Plan reflect existing carbon emissions policies that are assumed to continue. That is, the renewable portfolio standards (RPS) that have been adopted in three states, the new generation emissions standards adopted by three states, and renewable energy credits are included in the analysis. In addition, the plan recognizes that there are adopted goals for greenhouse gas emissions reductions for Oregon and Washington as well as proposed federal legislation. Most proposed policies to attain these goals rely on some system for putting a cost on carbon emissions. Whether these costs are the price of emission allowances under a cap-and-trade system, or some form of carbon tax, the costs imposed on the power system are a risk that the plan addresses. The plan includes resource actions that mitigate carbon risk along with other costs and risks faced by the regional power system.

The Council's assumptions on carbon price risk were based on consultations with a range of utility and other analysts and comparisons with a report by Ecosecurities Consulting Ltd. The assumptions are included in the Regional Portfolio Model as a distribution of 750 carbon price trajectories that range from zero to $100/ton, with an expected value of about $47/ton in 2030. A partial survey of regional utilities indicated that the range of prices the Council has included in its analysis is generally consistent with assumptions used in utility IRP analysis.

Accounting for regional power system carbon emissions requires a decision regarding the treatment of emissions associated with electricity that is imported and exported. The approach used for the Council's modeling is to count emissions by several generators that are located outside the region but whose output is committed to serving regional loads. These generators include parts of the Colstrip generation complex in eastern Montana, all of the Jim Bridger complex in Wyoming, and part of the Valmy generation complex in Nevada. Other imports and exports of energy are treated in two alternative accounting frameworks. One is referred to as "generation based" and counts emission from plants located within the region or contracted to regional utilities. The other approach is referred to as "load based" and counts emissions associated with imports and excludes emissions associated with the electricity exported from the region. For ease of exposition and comparability, most of the discussion in the plan refers to generation based carbon counting. In addition, the generation based carbon emissions are adjusted to be consistent with the accounting reflected in the Council's 2007 Carbon Footprint paper.7

There are also some complications in how to account for the estimated cost to the regional power system of carbon pricing policies. The default accounting of power system costs includes carbon penalties as though they were paid as a tax on every ton of carbon emitted. This approach is valid for modeling the penalties' effect on the development and operating decisions of the power system. However, the default accounting can significantly overestimate the total costs that the power system would recover from ratepayers, depending on the specific form of carbon penalty that the system faces. In particular, the current language of the U.S. House of Representatives proposal on climate policy includes a cap-and-trade system that grants free allowances to utilities that roughly offset their emissions until 2026. This approach would greatly reduce the cost impact on the power system, compared to a carbon tax on all emissions. To allow the reflection of different forms of carbon penalties, the portfolio model has an alternative accounting that excludes the amount of tax revenues. This alternative accounting provides a better estimate of the cost of a cap-and-trade free allowances mechanism to the power system.

The Council's plan provides a resource strategy that minimizes the cost of the future power system given the policy risks described above. A combination of aggressive conservation development, renewable resources, and in the longer-term, new gas-fired resources results in a reduction of power system carbon emissions from 57 million tons per year in 2005 to 37 million tons in 2030, which is below the 1990 emission level of 44 million tons. These reductions are generally consistent with the targets adopted by Northwest states.

The carbon cost risk assumptions play an important role in these results. If only current policies are assumed in the future, that is if no carbon pricing policies are implemented or expected, a least cost resource strategy would only stabilize carbon emissions from the power system at about current levels. Existing policies will not achieve the carbon emissions goals that exist in the WCI or some individual states in the region.

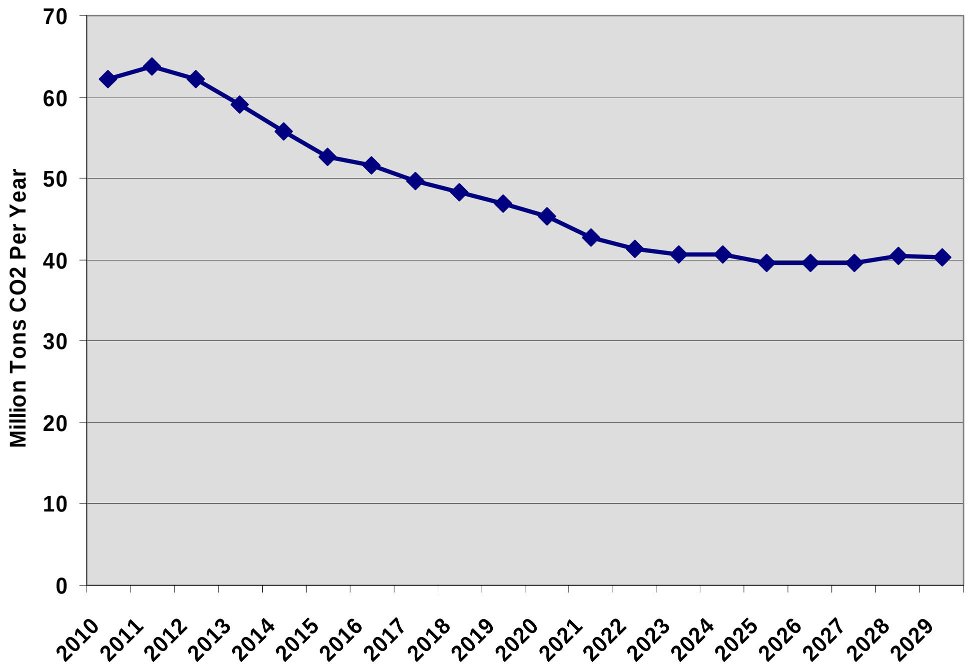
[7] Northwest Power and Conservation Council. Carbon Dioxide Footprint of the Northwest Power System. November 2007. (Council Document 2007-15)

The cost of moving from current policies to the $0 to $100 per ton carbon penalty scenario is significant. Response to the assumed carbon penalties increase power system costs by between 20 and 50 percent. The range in cost estimates depends on how policy is structured as described above. Current proposed federal policy provides free emission allowances under a cap-and-trade system for many years, which would put the cost impacts at near the lower end of the range. If power system costs increase by 20 percent, average retail rates would increase by about 3 percent compared to current policies.

To significantly lower carbon emissions from the power system, reliance on existing coal-fired generation would have to be reduced. This is not a surprising result because existing coal plants account for about 88 percent of the carbon emissions from the regional power system. In the $0 to $100 per ton carbon penalty scenario, these plants are simply used much less frequently. If they are used in that way, maintaining the plants may not be feasible for utilities. An alternative policy would be to phase out the existing coal plants or some portion of them. An analysis of phasing out all of the regional coal plants between 2012 and 2020 showed that power system 2030 carbon emissions could be reduced from 40 million tons in the $0 to $100 per ton carbon penalty scenario to about 15 million tons. Replacing the energy and capacity from the coal plants would increase average power system costs by about 30 percent. While this is an alternative policy approach to consider, it would not have the broad effects on other sectors and resource decisions that a cap-and-trade or tax system would have.

A number of scenarios addressed the issue of what level of carbon penalty would be required to meet alternative carbon emission reduction levels in 2030. The $0 to $100 per ton carbon penalty scenario, with average carbon prices growing to $47 per ton and possible futures between zero and $100, reduces average carbon emissions in 2030 to about 15 percent below 1990 levels. That is the WCI target for total greenhouse gas reduction by 2020. As shown in Figure 10-7, the $0 to $100 per ton carbon penalty scenario attains these reductions by 2020. However, these average reductions are not assured. In some futures, depending on demand, natural gas prices, hydroelectric conditions and carbon prices, emissions may not be reduced at all. These are cases where existing coal plants are utilized more intensively. The scenario where coal plants are retired results in more assured carbon reductions.

Figure 10-7: Average Sixth Power Plan Annual Carbon Emissions



Sensitivity analysis with the Regional Portfolio model and the AURORA$^{xmp®}$ Electric Market Model indicate that carbon costs of between $40 and $70 per ton would likely be required to reduce carbon emissions from the regional power system to below 1990 levels.

Just as coal-fired generation is the source of most of the power system's carbon emissions, the regional hydroelectric system is the source of most of the region's energy, capacity, and flexibility supply. As a carbon free resource, it is extremely valuable to the region. Because of the hydroelectric system, combined with the region's past accomplishments in conservation, the region's carbon emissions are half of that of the nation in terms of carbon emission per kilowatt-hour of energy consumption. Meeting the region's responsibilities for mitigating the fish and wildlife losses caused by the dams has depleted the capabilities of the hydroelectric system over time. The region should further reduce hydropower generation for salmon migration with careful analysis of the costs, risks and benefits of any proposed salmon mitigation action. The region needs to be sensitive to the fact that further reduction in hydroelectric generation will increase carbon emissions which will also harm fish and wildlife in the long term through accelerated climate change. For example, an analysis showed that removing the lower Snake River dams would undo 40 percent of the carbon reductions expected to be accomplished through the existing carbon policies in the region while also increasing the cost of the power system.