Chapter 11: Climate Change Issues

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 influence future resource choices. There remains a great deal of uncertainty surrounding both of these issues. This chapter describes how current and potential new policies affect the plan's resource strategy and what actions will be needed to achieve greenhouse gas emission-reduction goals. The issue of potential changes to electricity demand and hydroelectric generation is discussed in Appendix L.

The focus of climate policy, especially for the power 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 most of our electricity comes from hydroelectric generation. 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, natural gas, and nuclear, or from sequestering carbon.

Reductions in carbon emissions can be encouraged through various policy approaches such as regulatory mandates (e.g. renewable portfolio standard or emission standards), emissions cap-and-trade systems, emissions taxation, and efficiency-improvement programs. Climate change

policies enacted in the Northwest states have focused on renewable energy and new generation emission limits. National and Western 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.

Washington and Oregon have adopted specific greenhouse gas reduction targets. Similar targets exist for the Western Climate Initiative and in proposed national legislation. These goals imply reductions of 30 to 40 percent from 2005 levels by 2030. The Council's plan explores, through various scenario analyses, what actions must be taken to meet these targets in the most cost-effective manner. There are four critical elements to those actions. First is acquiring all of the efficiency improvements (which are significant) indentified in this plan's resource strategy. Second is reducing reliance on coal-fired generation to about half of current levels. Third is meeting renewable portfolio standards that already exist in three of the four Northwest states. Finally, the region needs to preserve the capability of the hydroelectric system to the greatest extent possible within the limits of fish and wildlife and other obligations.

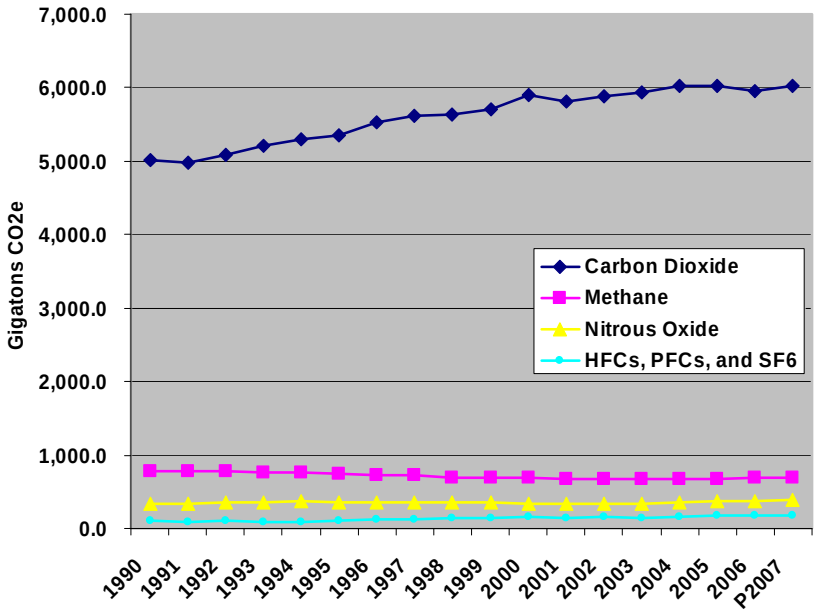
BACKGROUND

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 chlorofluorocarbon refrigerants. Different gases have different effects on warming and are rated as to their global warming potential. Carbon dioxide, which has become almost synonymous with greenhouse gases, has the least global warming potential. Many other gases have global warming potential thousands of times greater than carbon dioxide. Nevertheless, carbon dioxide has become the primary focus of climate change policy since it accounts for more than three-quarters of the world's greenhouse gas emissions. In the U.S., carbon accounts for 85 percent of emissions, and it is a growing source. Figure 11-1 shows that it is the primary source of greenhouse gas emissions growth in the United States since 1990. Levels of emissions from most other greenhouse gases 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 energy efficiency. Burning fossil fuel accounts for 94 percent of U.S. carbon dioxide emissions. Therefore, declining carbon dioxide emissions reflects a corresponding decline in energy use per dollar of gross domestic product.

[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

Figure 11-1: Sources of U.S. Greenhouse Gas Emissions, 1990 to 2007



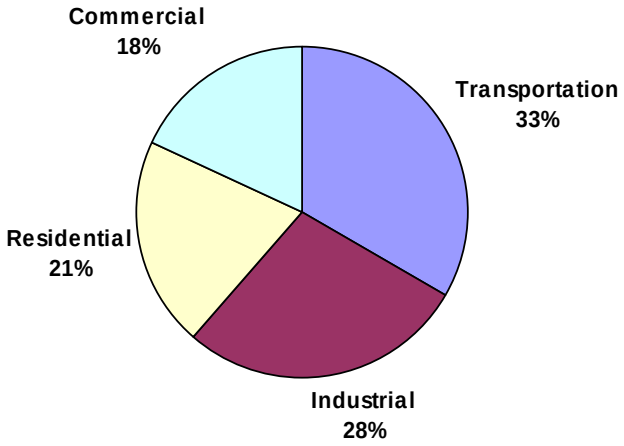
Source: U.S. Energy Information Administration

The National View

Electricity generation is the largest source of carbon dioxide emissions in the U.S. Electricity generation accounted for 38 percent of carbon dioxide emissions in 2005 (Figure 11-3). The next largest 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 for use in other sectors, too, and when emissions are added to those sectors, a different allocation results. When carbon emissions are connected to human activities, transportation becomes the largest carbon-emitting sector. Figure 11-2 shows the sources of carbon dioxide emission by end-use sector in the U.S.

This implies that to reduce carbon dioxide emissions from the electricity sector, policies should address both electricity generation and energy efficiency. Improved energy efficiency reduces the need to generate electricity in the first place. 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 are all options. Policies should target both sides of the electricity equation, with priority given to the lowest-cost approaches. Furthermore, policies should also address emissions from the direct use of fossil fuel in other sectors, including transportation.

Figure 11-2: 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

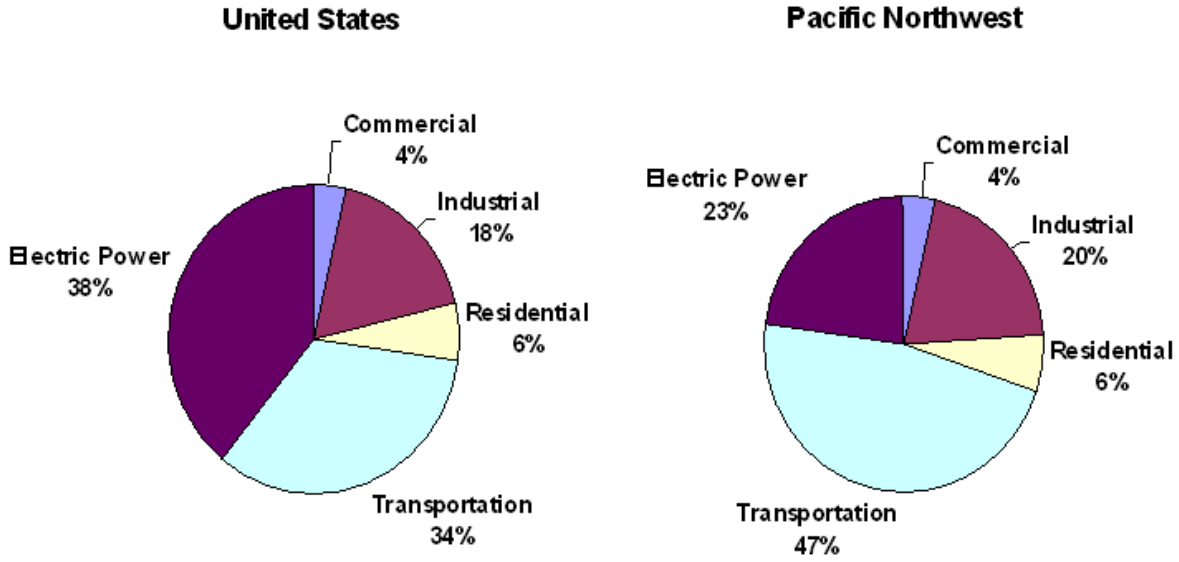
The sources of carbon emissions in the Pacific Northwest are not typical of the U.S. Figure 11-3 compares the shares of carbon dioxide emissions from economic sectors for the U.S. and the four Northwest states. Unlike Figure 11-2, emissions from electricity generation are included in the electric power sector in Figure 11-3. 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., electricity generation 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's electricity supply.

The years 1990 and 2005 are frequently used as benchmarks in policies for the control of greenhouse gases.[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 carbon production over the next 15 years. By 2005, the most recent year for which electricity production or fuel consumption data are available, carbon production increased 52 percent to 67 million tons (Figure 11-4). This is approximately the carbon output of 23 400-megawatt

[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 greenhouse gas emissions to 15 percent below 2005 levels by 2020.

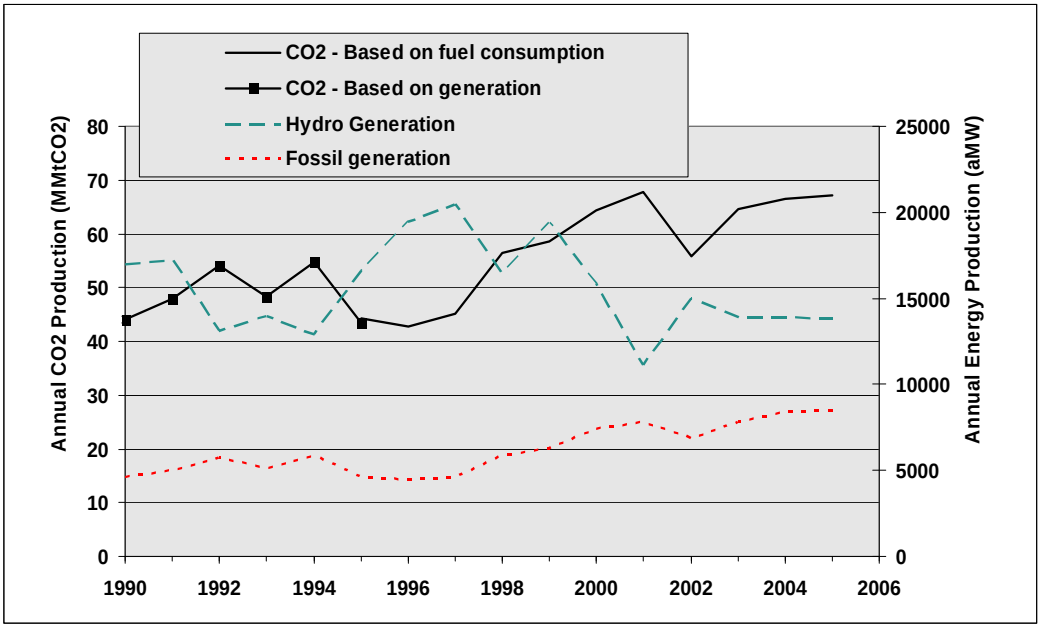
conventional coal-fired power plants, 56 400-megawatt gas-fired combined-cycle plants or about 11.7 million average U.S. passenger vehicles.

Figure 11-3: Energy Carbon Emissions by Sector, 2005



Regional carbon production estimates from 1995 through 2005, shown in Figure 11-4, 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 11-4: Growth of CO_2 Emissions from Electricity Generation in the Pacific Northwest



Annual hydropower conditions can greatly affect power system carbon production. Average hydropower production in the Northwest is about 16,000 average megawatts. As shown by the plot of Northwest hydropower production in Figure 11-4, the 1990 water year was nearly 17,000 average megawatts, slightly better than average. Other factors being equal, this would have slightly reduced carbon production that year because additional hydroelectric generation would have displaced 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 carbon production. This effect of hydropower generation on thermal plant dispatch and carbon production is apparent in Figure 11-4.[3]

If the estimated CO_2 production in 2005 were normalized to average hydropower conditions, emissions would have been 57 million tons instead of 67 million tons, a 29 percent increase over the 1990 rate. Current targets have not been clear about this adjustment, but without adjustment, a goal based on 2005 emissions would be much easier to meet than one based on 1990. In the power plan, the Council has used the adjusted-to-normal hydro value for 2005 so that the number will be comparable to forecasts of average emissions in the plan's scenarios. It should be clear, however, from the discussion and Figure 11-4 that average carbon emissions will disguise significant carbon emissions sensitivity to hydro conditions in the region.

ACTIONS TO REDUCE GREENHOUSE GAS EMISSIONS

From a broad perspective, there are three things we can do to reduce carbon dioxide emissions: generate electricity from lower or zero carbon-emitting fuel, use less electricity, or sequester or

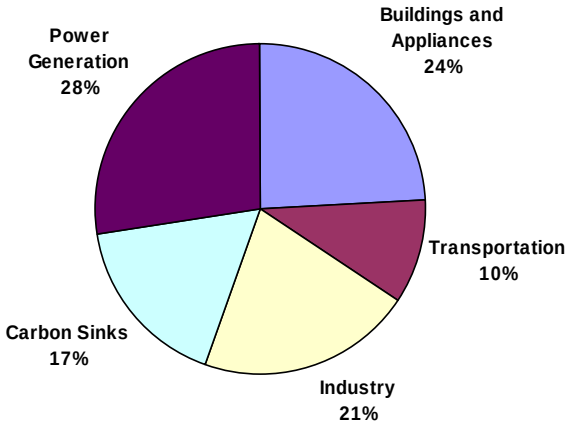
[3] In Figure 11-4, it is evident that Northwest thermal generation does not decline as much as Northwest hydro generation increases in above average water years, e.g. 1994 - 1997. This is likely due to the fact that the abundant hydropower of good water years creates a regional energy surplus that can be sold out of the region where it displaces thermal generation, which often consists of older, less efficient gas-fired units.

offset carbon that is released. In 2007, McKinsey and Company studied how much greenhouse gas reduction was possible in the U.S. and what it might cost.[4] The McKinsey report looked at alternative actions to reduce greenhouse emissions. They assumed that without actions, greenhouse gas 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 reductions could be done at no cost. Nearly all of this came from improved energy efficiency in buildings or vehicles. The remaining 60 percent of greenhouse gas reduction came from an array of actions that increased in cost as reductions grew. The most expensive option 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 11-5. As with the case for Figure 11-2, emission reductions from energy efficiency are counted in the sector where electricity is consumed.

Figure 11-5: Estimated Sources for a 3 Billion Ton Reduction of GHG Emissions by 2030



There are some interesting observations to make about the McKinsey results. Although a great deal of the policy discussion on carbon reduction focuses 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 is hybrid vehicles. In the McKinsey analysis, it is the most expensive alternative shown (around $90/ton) and it has relatively small potential for carbon

[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.

reduction. The plug-in hybrid option was not needed to reach the 3.0 billion ton reduction case. However, improved efficiency of conventional vehicles has far more potential to lower carbon emissions in the short-term, and it is less expensive than PHEV.

If the goal is to stabilize greenhouse gas 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 climate change 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 greenhouse gas emissions would need to be reduced to about one-quarter of today's emissions by 2100 to stabilize their atmospheric concentrations.

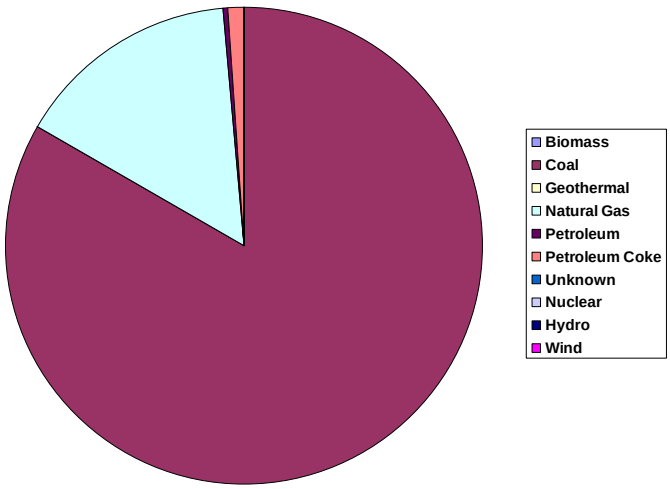
There have been many studies on the costs of particular climate change policies. The usual purpose has been to try to estimate the price of carbon that is likely to be associated with a policy. EcoSecurities Consulting Limited conducted a study for the Council to determine a range of likely carbon costs for the plan's analysis. EcoSecurities reviewed many studies and provided a set of alternative estimates based on their models of supply curves for carbon-mitigation actions. In addition, Point Carbon reviewed the results of seven studies of the Lieberman-Warner bill for the Bonneville Power Administration, 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. 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 move toward the Intergovernmental Panel on Climate Change goal of stabilizing emissions 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's horizon. This possible but uncertain cost of carbon has a significant influence on the plan's resource strategy. Energy efficiency, 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 costs, it is clear that improved efficiency is available in significant amounts and at low cost without adding 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 more expensive. Many other renewable resources--coal with carbon separation and sequestration and advanced nuclear--may become available within the Council's planning horizon, but they are not currently available or are very expensive.

To achieve 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 11-6, existing coal-fired power plants account for about 88 percent of the region's emissions. Therefore, the region could not reduce its power system emissions below 1990 levels, as some targets require, if the region's coal plants continue to operate as they do now. 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 need additional investment to continue 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: cap-and-trade programs, direct taxation of emissions, regulatory programs that limit emissions or require non-emitting resources to be developed, and efforts to improve energy efficiency. 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 the emissions of new power plants have been the prevailing policies. The Council has primarily focused on energy efficiency, and states, utilities, and the federal government have initiatives to improve efficiency 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 approach has advantages and disadvantages.

Mandates

Mandates direct companies and individuals to acquire or produce equipment that meets an approved standard of energy efficiency or uses approved types of energy. One example 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 do not 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 and a number of states elsewhere in the country have passed laws (renewable portfolio standards) that require utilities to increase generation from renewable resources. These or related laws have in some cases also required generators that use non-renewable fuel to keep their emissions below a maximum emissions per kilowatt-hour standard (e.g., Washington and California).

Mandates have the advantage of being simple and are fairly easy to enforce. They have the disadvantage that they are inflexible in the face of changing technology or other conditions. Unless made sufficiently flexible, a mandate would focus policy on only one approach to reducing carbon emissions and not consider other alternatives that might be more effective or less expensive.

Tax Incentives

Tax incentives will help by reducing the overall investment in preferred resources and equipment through accelerated depreciation, tax credits, or various forms of tax exemptions. Such tax incentives have been extended to hybrid cars, wind generators, 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 in that the credit is based on the actual generation, 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 sulfur dioxide and nitrogen oxide was established as part of the 1990 Clean Air Act. This policy is generally regarded as a success, resulting in faster reductions in sulfur dioxide 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 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 the retail prices of energy, at least theoretically providing appropriate price signals to consumers.

As a policy with the goal of reducing emissions of greenhouse gases, 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, carbon tax policy has a more predictable total cost, but a less predictable total reduction in emissions.

Finally, cap-and-trade programs need to develop a market to trade emission allowances. The market mechanism offers the potential for emission reductions at low costs. But developing a market to trade newly-created assets like emission allowances requires careful consideration to ensure that the market will function as expected.

Carbon Taxes

A carbon tax would likely apply not only to carbon, but to all greenhouse gases in proportion to their climate-changing effects, and would tax emissions at a level to control and mitigate climate change.

A carbon tax has the advantage of being easier to administer than a cap-and-trade system and the cost is predictable, but the carbon reductions are less certain. A cap-and-trade program makes carbon reductions more predictable, but it is complex to administer and the total cost is unpredictable.

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 gases.

CURRENT POLICIES AND GOALS AFFECTING THE PACIFIC NORTHWEST

At present, carbon reduction policies regionally, nationally, and globally are still very much in a state of flux. Reduction goals range from stabilizing emissions at current levels to reducing emissions to 1990 levels or below.

International Initiatives

Significant international initiatives targeted at climate change can probably be dated from 1992, when the United Nation's 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 reduction targets for developed countries to meet by the 2008-2012 period. The Kyoto Protocol, in spite of the withdrawal of the U.S. in 2001, has been ratified by 182 countries, including 37 industrialized countries that account for over 60 percent of the emissions from developed countries.

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 reductions. The system has experienced episodes of price volatility, which has been attributed to imperfect data and the 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 degrees Celsius (3.6 degrees Fahrenheit) and has translated that goal into emission-reduction targets for developed countries. Those targets call for an 80 percent to 95 percent reduction relative to 1990 levels by 2050.

Federal Policies

Environmental Protection Agency Role

On April 2, 2007, in *Massachusetts v. EPA*, 549 U.S. 497 (2007), the Supreme Court found that greenhouse gases are air pollutants covered by the Clean Air Act. The Court held that the administrator must determine whether or not emissions of greenhouse gases from new motor vehicles cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision.

On December 7, 2009, the Environmental Protection Agency administrator signed two distinct findings[6] regarding greenhouse gases under section 202(a) of the Clean Air Act:

- that the current and projected concentrations of six key greenhouse gases, including carbon dioxide in the atmosphere threaten the public health and welfare of current and future generations and

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

[6] The Environmental Protection Agency findings are found in "40 CFR Chapter I Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act; Final Rule" and were published on December 15, 2009 in the *Federal Register* under Docket ID No. EPA-HQ-OAR-2009-0171. The final rule will be effective January 14, 2010.

- that the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas pollution which threatens public health and welfare.

These findings currently do not impose any requirements on industry or other entities. However, they are a prerequisite to finalizing the EPA's proposed greenhouse gas emission standards for light-duty vehicles, which were jointly proposed by EPA and the Department of Transportation's National Highway Safety Administration on September 15, 2009.

These findings also are not likely to have a significant adverse effect on the supply, distribution, or use of energy because they do not impose any requirements at this time.[7] There remains a possibility that the EPA could impose greenhouse gas emission limits on electricity generators at some time in the future; however, the current administration has indicated a preference to control greenhouse gases via legislation as opposed to EPA mandates.

Legislative Efforts

There have been a series of proposals for national legislation on climate change. The most recent serves as an example of the policy being discussed. The Waxman-Markey draft legislation, entitled "The American Clean Energy and Security Act of 2009," proposed a comprehensive strategy for energy planning and use. The legislation contained provisions to increase use of renewable energy and to improve efficiency. It would require electric utilities to meet 25 percent of their load with a combination of renewable energy and efficiency improvements by 2025. In addition, it proposes creation of a greenhouse gas tradable allowance system that would reduce emission allowances to 83 percent lower that 2005 levels by 2050. The bill also contained numerous other provisions providing assistance for reducing emissions and directing EPA to take specific actions.

Regional Policies

The Western Climate Initiative (WCI) is a broad regional effort to implement policies to reduce greenhouse gas emissions. The governors of Oregon, Washington, and Montana have joined five other Western state governors and the premiers of four Canadian provinces to implement policies that address climate change. The overall goal of the WCI is to reduce the region's greenhouse gas emissions to 15 percent below 2005 levels by 2020. The primary policy objective of the WCI is to implement 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 fuel and fuel burned at industrial, commercial, and residential buildings.

The WCI's work has made it clear that a regional cap-and-trade program faces problems that a national or international program does not. For example, because individual states and provinces

[7] See "H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use."

have significant flexibility to modify their jurisdiction's reduction targets, the allocations are a source of potential conflict. Another example is the potential for "leakage" that can result from shifting emissions from inside the WCI to the outside. Such a shift would allow WCI emission targets to be met, but with no net reduction in global emissions. Leakage becomes less likely as the geographic scope of the cap-and-trade program expands to the national or international level.

State Policies

Policy initiatives at the state level to address climate change are numerous, but three types of state policy predominate: greenhouse gas reduction goals; renewable portfolio standards; and emission performance standards. There is 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 greenhouse gas production, but the focus here is on policies that have the greatest relevance to the Sixth Power Plan.

Greenhouse Gas Emission Reduction Goals

The 2007 Oregon Legislature set greenhouse gas 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 Legislature is also considering WCI cap-and-trade legislation. House Bill 1819 and Senate Bill 5735 would codify the state's 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.

Renewable Portfolio Standards

Since the adoption of the Fifth Power Plan, renewable resource portfolio standards that mandate developing certain types and amounts of resources have been adopted by Oregon, Montana, and Washington. Similar standards have been adopted by Arizona, British Columbia, California, Colorado, New Mexico, and Nevada. The key characteristics of the Pacific Northwest states' 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 this plan's 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 fueled by coal unless a minimum of 50 percent 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 percent.

Oregon: Since 1997, the developers of new power plants in Oregon have had to offset their carbon dioxide emissions to a level 17 percent 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's 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 will 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 fueled by natural gas.

Washington: Since 2004, Washington has required fossil-fueled power plants of 25 megawatts or greater to offset or otherwise mitigate carbon dioxide emissions by 20 percent. In addition, RCW 80.80, 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 outside the state. Modeled on California Senate Bill 1368, the law defines baseload electrical generating facilities as facilities designed to produce electricity at a 60 percent capacity factor or greater. The law adopts the initial California limit of 1,100 lbs/CO_2 per megawatt-hour, 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 megawatt-hour (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 implement a carbon dioxide separation and sequestration regime (if the technology is available), as long as average lifetime emissions comply with the emissions performance standard.

EVALUATING CARBON STRATEGIES

Existing climate change policies, such as the Oregon and Washington emission reduction goals, as well as proposed future policies were factors in developing the Sixth Power Plan's resource strategy.

The recommended actions in the Sixth Power Plan reflect existing carbon emissions policies that are assumed to continue. That is, the renewable portfolio standards 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 and are assumed to be enforced. 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 with similar goals. 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, 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 reviews of studies by others, including a report done for the Council by Ecosecurities Consulting Ltd. The assumptions are included in the regional portfolio model's carbon risk study as a distribution of 750 carbon-price trajectories that range from zero to $100 per 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 included in its analysis is generally consistent with assumptions used in their analyses.

Tracking power system emissions in the region requires a definition on how to treat emissions from electricity that is imported and exported. The emissions reported in this plan include those from generators located outside the region, but whose output is committed to serving regional load. 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. This approach is referred to as "generation based." The regional portfolio model also reports another approach referred to as "load based" carbon emissions. This alternative approach 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.[8]

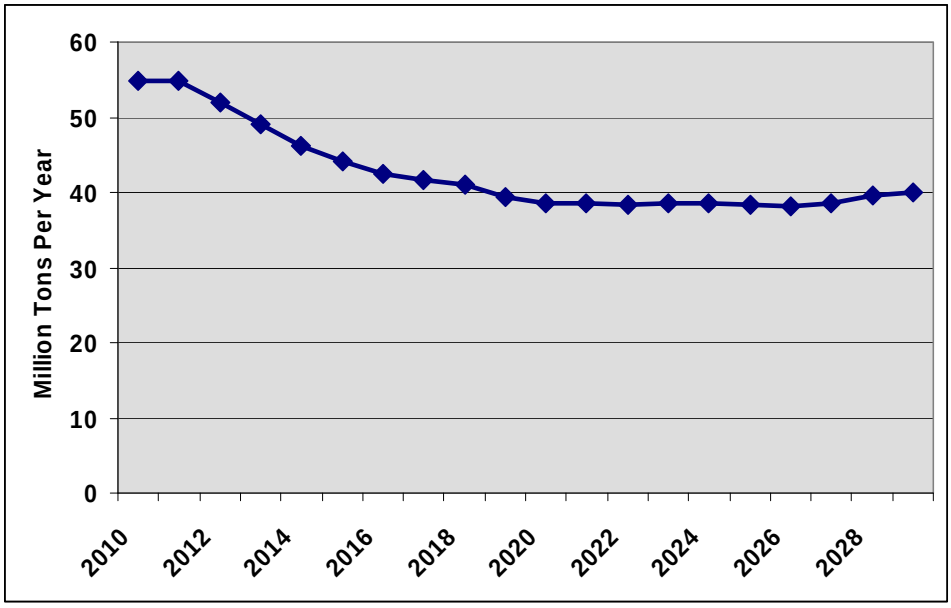
There are also some complications in how to account for the estimated cost of carbon-pricing policies to the regional power system. The default accounting of power system costs in the Council's models includes carbon penalties as though they were paid as a tax on every ton of carbon emitted. This approach is valid for modeling the penalties' effect on power system development and operating decisions. However, the default accounting can significantly overestimate the total costs that the power system would recover from ratepayers, depending on the kind of carbon penalty the system faces. In particular, the current language of the U.S.

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

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 to the power system, compared to a carbon tax on all emissions. To include the effect of different forms of carbon penalties, the regional portfolio model has an alternative accounting that excludes the amount of tax revenues. This alternative accounting provides a better cost estimate 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. A combination of aggressive development of energy efficiency, 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 40 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 reduced carbon emissions depend on efficiency improvements and other low-emission generation displacing the reliance on existing coal plants. Figure 11-7 shows the projected average carbon emissions over time in the carbon risk scenario. That scenario on average meets or exceeds the 2020 targets adopted by Washington, Oregon, the WCI, and the Waxman/Markey proposed legislation.

Figure 11-7: Average Sixth Power Plan Annual Carbon Emissions



The carbon-cost risk assumptions play an important role in these results. If only current policies are assumed in the future--and no carbon pricing policies are implemented or expected--a least-cost resource strategy would stabilize carbon emissions from the power system at around current levels. Current policies arrest the growth of carbon emissions because of aggressive efficiency improvements, which are cost-effective even without carbon penalties, and increased acquisition of renewable generation. But existing policies will not achieve the carbon emissions goals of the WCI or of some individual states in the region.

The cost of moving from current policy to the carbon risk scenario is significant. Responding to the risk of carbon penalties in the $0 to $100 per ton range increases power system costs by 14 percent. When the carbon penalty is included, the cost increase is estimated to be 41 percent.

The extent to which the carbon penalty is a net cost to the power system or region depends on how that policy is structured. Current proposed federal policy provides free emission allowances under a cap-and-trade system for many years, which would put the cost impact near the lower end of the range. If power system costs increase by 14 percent, average electricity revenue requirements would increase by about 2 percent compared to current policies. However, the cost increase would not be spread evenly among the regional utilities and consumers. Utilities that are more reliant on coal-fired generation would bear a larger part of the cost of carbon emission reduction.

To significantly lower carbon emissions from the power system, existing coal-fired generation would have to be reduced. This is not surprising since existing coal plants account for about 88 percent of the carbon emissions from the regional power system. In the carbon risk scenario, carbon reductions occur because these plants are used much less frequently. In doing so, however, maintaining the plants may not be economically feasible for utilities. In addition, while carbon emissions are reduced to target levels on average, the certainty of achieving targets is low. Depending on how some future uncertainties unfold, such as hydro conditions, carbon prices, and other factors, emissions can vary greatly and need not fall below the targets.

Two alternative scenarios were analyzed that provided more clarity with regard to what the region would need to do to meet a specific carbon reduction target in the 35 to 40 million tons per year range. One of those scenarios implemented a fixed $45 per ton carbon penalty, which was sufficiently high to reach the emissions target. That scenario resulted in average 2030 carbon emissions of 37 million tons, 35 percent below 2005 levels. In addition, the likelihood of attaining the desired reductions is somewhat higher than in the $0 to $100 per ton scenario.

The second of these scenarios phased out existing coal generation until emission targets were met. This coal retirement scenario retired about half of the coal-fired generation serving the region. Average 2030 carbon emissions were reduced to 36 million tons. Importantly, the certainty of carbon reductions is much greater in the coal retirement scenario. Replacing the energy and capacity from coal plants would increase average power system costs by about 15 percent above the current policy scenario. While this is an alternative policy approach to consider, it would not have the broad effect on other sectors and resource decisions that a cap-and-trade or tax would have. If a coal retirement policy were implemented in combination with a carbon penalty, fewer coal plants would need to be retired, but the remaining plants would still be used less frequently in response to the carbon prices. These scenarios are discussed further in Chapter 10.

In summary, there are four things the region would have to do to meet existing 2030 carbon reduction targets. First, the efficiency of electricity use has to be improved to save nearly 6,000 average megawatts by 2030. These efficiency improvements are key to reducing carbon emissions. In the carbon risk scenario, efficiency improvements lower 2030 carbon emissions by 17 million tons per year. Without efficiency improvements, carbon prices modeled in the carbon risk scenario would only stabilize emissions at the 2005 level. Second, renewable portfolio standards adopted in three of the four Northwest states must be implemented. These resources play a significant role by reducing the amount of carbon-emitting generation. Third, the use of coal-fired generation must be further reduced either by policy or by carbon penalties. In all three of the scenarios that meet carbon reduction goals, coal-fired generation is reduced by about half

from current levels. Finally, the region needs to preserve the capability of the hydroelectric system to the greatest extent possible within the limits of fish and wildlife obligations.

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 energy efficiency, the region's carbon emissions are half the nation's 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. If the region needs to further reduce hydroelectric generation for fish and wildlife survival, it should do so with careful analysis of the costs, risks, and benefits of the proposed actions. 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 in the draft plan 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.