Chapter 9: Recommended Resource Strategy

SUMMARY OF KEY FINDINGS

The resource strategy of the Sixth Power Plan was developed by examining a number of different planning scenarios. The Resource Portfolio Model (RPM) identifies resource plans that minimize the cost and risk of future power system costs as described in Chapter 8. As in previous plans, improved efficiency of electricity use is the most cost-effective and least risky resource available to the region. The value of conservation was recognized in all planning scenarios and all scenarios call for developing significant amounts of conservation. The amount of conservation that is cost-effective changes very little regardless of assumptions about carbon costs and policies. Due to advancing technologies, new applications, much higher energy costs, and the risk of carbon emission penalties, much more conservation is available and cost-effective in the Sixth Plan. Therefore, the Sixth Power Plan calls for aggressive development of conservation. There is enough cost-effective conservation in the resource portfolio to provide a substantial portion of the region's load growth.

In addition to efficiency improvements, new renewable generation (primarily wind) is required to meet renewable portfolio standards in Washington, Oregon, and Montana. Analysis shows that meeting RPS requirements uses most of the readily accessible wind potential (5,300 MW) in the region. In addition to the wind, some geothermal resources enter the plan. However, the amount of geothermal potential is considered quite limited. In planning scenarios without the RPS requirements, about one third less renewable development would be optimal given the carbon price risk considered. Instead more conservation would be developed and some additional gas-fired generation would be optioned.

Reducing carbon emissions from the power system will increase the future cost of electricity and increase consumers' electric bills. The risk of carbon prices between $0 and $100 is estimated to increase average electricity rates by about 2.4 to 9.3 compared to current policies that only include renewable portfolio standards, renewable energy credits and limits on new power plants carbon emissions. The effect on average residential consumers' monthly bills is estimated as an increase 1.4 to 7.1 percent.

The effects of carbon pricing risk are reduced in the Pacific Northwest by the existing hydroelectric system and the relatively minor role of coal-fired generation. The resource strategy focus on conservation and renewable generation also help avoid future cost impacts.

ROLE OF ANALYSIS IN THE RESOURCE STRATEGY

The Council uses several computer models in the process of developing its Power Plan. These include demand forecasting models, market price forecasting models, hydroelectric simulation models, resource financial costing models, and the Regional Portfolio Model (RPM) discussed in Chapter 8. All of these models help the Council combine the best information available to identify a resource strategy that minimizes the future cost of the power system as required by the Northwest Power Act, and also includes strategies to mitigate the risks of unknown future conditions.

The Council's models and analyses help inform the resource strategy, but models are limited in their ability to address all of the considerations that need to go into the Power Plan. The Council's plan recognizes that available models do not capture the local limitations of the transmission system, for example, or the unique situations faced by all individual utilities. As a result, the resource strategies that result from particular model analyses are supplemented by additional information to come up with the Council's recommended resource strategy.

In addition, the resource strategy is supplemented by additional information about potential future resources, explanations of special challenges facing the power system, and an action plan containing steps the region should take to implement the plan. The action plan addresses important issues like wind integration, conservation acquisition, resource development and confirmation, and research and demonstration projects.

THE RESOURCE STRATEGY

Planning Scenarios

The Resource Portfolio Model analyzes the Power Plan's forecasts of demand, conservation supply, and generating resource alternatives. The RPM is unique because it is acknowledges that forecasts are well-informed but uncertain. The RPM considers risk in its analysis, including the risk that the Council's forecasts are incorrect. It adds a range of climate policy and other unknown future conditions to identify least-cost and least-risk plans along an efficient frontier of least-cost resource plans. This process is described in Chapter 8. The RPM searches through thousands of potential portfolios to estimate how each one would perform in 750 futures. This analysis allows the program to find the lowest cost resource portfolios for different levels of risk. In more typical planning these futures would generally be called "scenarios." In the RPM the

Council refers to these as "futures," and the term "scenario" is reserved for different RPM runs as described below.

In developing its resource strategy, the Council evaluated several scenarios focused primarily on different climate policy approaches to see if the resource strategy is sensitive to such differences. Below is a list of scenarios considered. Each scenario analyzed produced a least-cost and least-risk mix of resources. The scenarios are described here in terms of their least-risk portfolio of resources. Resource plans at the lowest cost end of the frontier tend to rely on electricity markets instead of optioning and building resources. Plans at the low-risk end of the efficient frontier produce more adequate and reliable power systems, reduce electric price volatility, and provide more information about the types and amounts of resources needed. For these reasons the Council has focused on least-risk plans.

- *Current Policy* is a scenario that includes renewable portfolio standards that exist in three of the four Northwest states, renewable energy credits, and new carbon emissions performance standards that preclude the construction of new coal plants. The current policy scenario does not, however, include the stated emissions reduction goals that some states have adopted as policy.

- *No Policy* is a scenario that assumes no renewable portfolio standards or other policies aimed at reducing carbon emissions exist. However, it does not allow new coal-fired generation.

- *$0 to $100 Carbon* is a scenario that adds to the Current Policy scenario uncertain carbon pricing policy that can vary from zero to $100 per ton of carbon emission. The carbon cost range for this scenario was based on staff analysis and a study that reviewed various cost estimates that would successfully achieve carbon reduction.

- *No RPS* takes renewable portfolio standards out of the $0 to $100 Carbon scenario to test whether a strategy to mitigate risk of future carbon pricing would develop as much renewable generation as the RPS requirements.

- *$0 to $50 Carbon* tests the effects of a smaller range of potential carbon price risks on the resource plan.

- *$100 Carbon* puts a firm price on carbon emissions of $100 per ton. The price is not a risk in this scenario, it is a known cost.

- *$20 Carbon* puts a price on carbon emissions of $20 per ton. As in the $100 scenario, it is a known cost.

- *Retire Coal w/ CO2* phases out existing coal plants between 2015 and 2020 but retains uncertain carbon pricing policy that can be between $0 and $100.

- *Retire Coal w/0 CO2* phases out existing coal plants between 2015 and 2020 but considers that action a substitute for carbon pricing policy and does not include carbon price risk.

- *Dam Removal* assumes that the four Lower Snake River dams are removed in 2020 in order to test the value of the hydroelectric capability of the power system.

- *Low Conservation* assumes a reduced acquisition rate for discretionary conservation and lower penetration of lost-opportunity conservation.

- *High Conservation* assumes a higher acquisition rate for discretionary conservation.

The Resource Strategy

The Council developed a resource strategy based on analysis of the results of all of these scenarios as well as other considerations to supplement the model results. What emerges is a clearly focused strategy for near-term actions and flexible guidance on future resources and actions.

The resource strategy is summarized below in six elements. The first three are high-priority actions that should be pursued immediately and aggressively. The longer-term actions must be more responsive to changing conditions to provide an array of solutions to meet the long-term needs of the regional power system. The last element recognizes the adaptive nature of the power plan and commits the Council to regular monitoring of the regional power system to identify and adjust to changing conditions.

- **Conservation:** The region should aggressively develop conservation with a goal of acquiring 1,200 average megawatts by 2014, and 5,800 average megawatts by 2030. Conservation is by far the least-expensive resource available to the region and it avoids risks of volatile fuel prices, financial risks associated with large-scale resources, and it mitigates the risk of potential carbon pricing policies that would address climate change concerns.

- **Renewables:** The region should meet existing renewable portfolio standards. Most of the recent renewable development has been wind and that is assumed to be the primary source of renewable energy in the immediate future. Wind's variable energy production creates little dependable peak capacity and increases the need for within-hour balancing reserves. The Council encourages the development of other renewable alternatives that may be available at the local, small-scale level and cost-effective now. The Council also supports research and demonstration into different sources of renewable energy for the future. On average, the renewable resources developed to fulfill state RPS mandates should contribute 1,800 average megawatts of energy, or 5,600 megawatts of installed capacity.

- **Wind Integration:** The Plan encourages the region to improve wind scheduling and system operating procedures as a more cost-effective and more quickly achievable alternative to new gas-fired generation for the purpose of wind integration.

- **Natural Gas:** The region may need to develop new natural gas resources, depending on load growth and the possible need to displace coal use to meet high carbon reduction goals. Even if the region has adequate resources, individual utilities or areas may need additional supply for capacity or wind integration. In these cases, the strategy relies on natural gas-fired generation to provide energy, capacity, and ancillary services.

- **Future Resources:** In the long term, the Council encourages the region to expand the alternative resources available to the region. Among these are additional sources of renewable energy, improved regional transmission capability, new conservation technologies, new energy storage techniques, carbon capture and sequestration, smart grid and demand response resources, and new or advanced generating technologies, including advanced nuclear energy. Research, development, and demonstration funding should be prioritized in areas where the Northwest has a comparative advantage or unique opportunities.

- **Adapting to Change:** The Council will regularly assess the adequacy of the regional power system to guard against power shortages, identify departures from planning assumptions that could require adjustments to the Plan, and help ensure the successful implementation of the Council's Fish and Wildlife Program.

The following sections describe the basis for the resource focus on conservation, renewable generation and natural gas.

Conservation

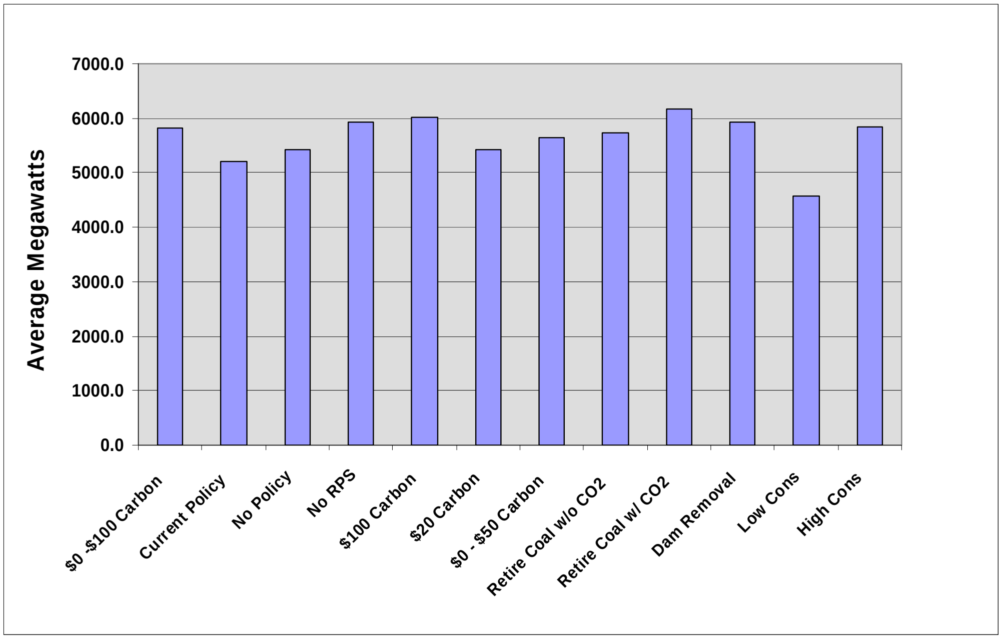
The Council's research on conservation potential demonstrated a large potential for improved efficiency of electricity use. Increased costs of electricity generation, new areas of application and changing technologies mean this potential is much larger than the potential identified in the Council's Fifth Power Plan.

Conservation is the clear priority resource as evaluated by the RPM. It is by far the lowest cost resource and provides protection against the risks of volatile natural gas prices, high electricity prices and the possibility of carbon pricing policies. Conservation also has the risk advantages associated with small scale resources that require less time to develop.

Each portfolio, regardless of the scenario analyzed, contained conservation in the range of 5,200 and 6,200 average megawatts. The one exception is the Low Conservation scenario in which the rate of development for conservation was further limited. Figure 9-1 illustrates the level of conservation included in the least-risk plan for each scenario.

Similar amounts of conservation are cost effective regardless of the assumption about climate policies. Even in the Current Policy and No Carbon Policy scenarios, conservation was demonstrated to have clear advantages. It is interesting to note that Current Policy reduces the amount of conservation compared to No Carbon Policy. Renewable portfolio standards force the addition of renewable generation and both reduce resource needs and mitigate some of the risk from fuel prices. The fact that varying levels of conservation are driven partly by resource needs is also evident in the other scenarios. Scenarios with high-carbon prices result in reduced operations of existing coal plants, making replacement energy more valuable. This effect is most clear in the scenarios that retire currently generating coal plants.

Figure 9-1: Cost-Effective Conservation Resources



Renewable Generation

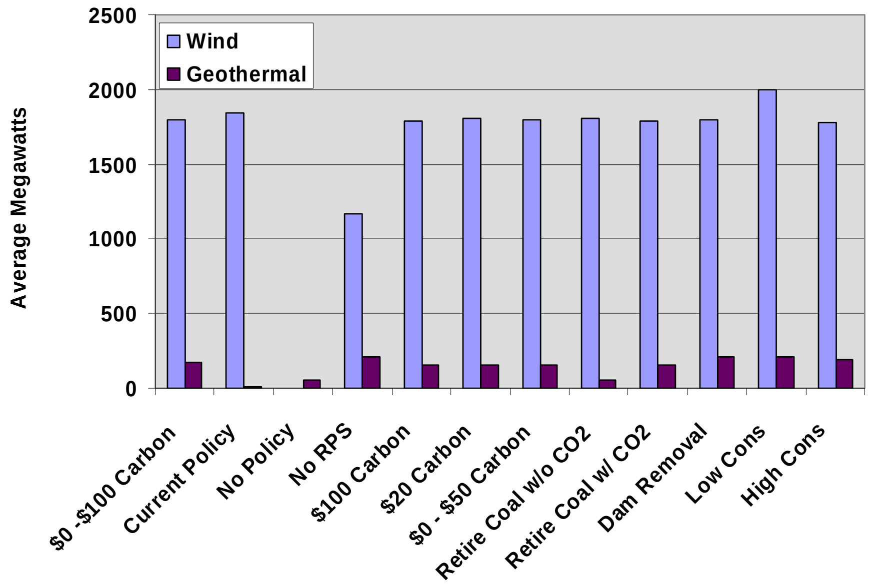
Renewable resources are mostly modeled as wind in the RPM. A limited amount of geothermal is included in the resource alternatives and is generally an attractive resource choice. The Council has recognized that additional small-scale renewable resources are likely available and cost-effective and the Plan encourages development of them. In addition, there are many potential renewable resources that are currently either too expensive or unproven technologies that may, with additional research and demonstration, prove to be valuable resources.

Wind development in the various scenarios is driven primarily by state renewable portfolio standards. The amount of wind energy acquired depends on the future demand for electricity because state requirements specify percentages of demand that have to be met with qualifying renewable sources of energy. Across the 750 futures of demand growth the amount of wind developed on average is 1,800 average megawatts. In terms of available capacity, that is 5,600 megawatts of installed wind capacity, but only about 300 megawatts of firm peaking capacity.

Figure 9-2 shows the amounts of wind and geothermal energy acquired on average in the various scenarios studied. 860 average megawatts of wind (2,700 megawatts of available capacity) exists in all scenarios because that level of development already exists or is committed to be developed. In all cases with renewable portfolio standards in place, the development of wind is limited to 1,800 average megawatts as required by the standards when the state's goals are combined. The only exception to this is when low rates of conservation are assumed. In that case, an additional 200 megawatts of wind is developed.

In the two scenarios without renewable portfolio standards, No Carbon Policy and No RPS, the results are different. In the No Carbon Policy scenario no additional wind is developed. In the No RPS scenario, which includes the risk of carbon prices between $0 and $100 per ton, additional wind is developed, but only about 1,200 average megawatts instead of the 1,800 average megawatts in the scenarios that include renewable portfolio standards.

Figure 9-2: Renewable Resource Development



Geothermal energy is considered cost-effective in many of the scenarios although the amount available is quite small. The Council expects that the geothermal resource may be representative of other small-scale, locally available renewable generation that offers dependable energy capability and peaking contribution.

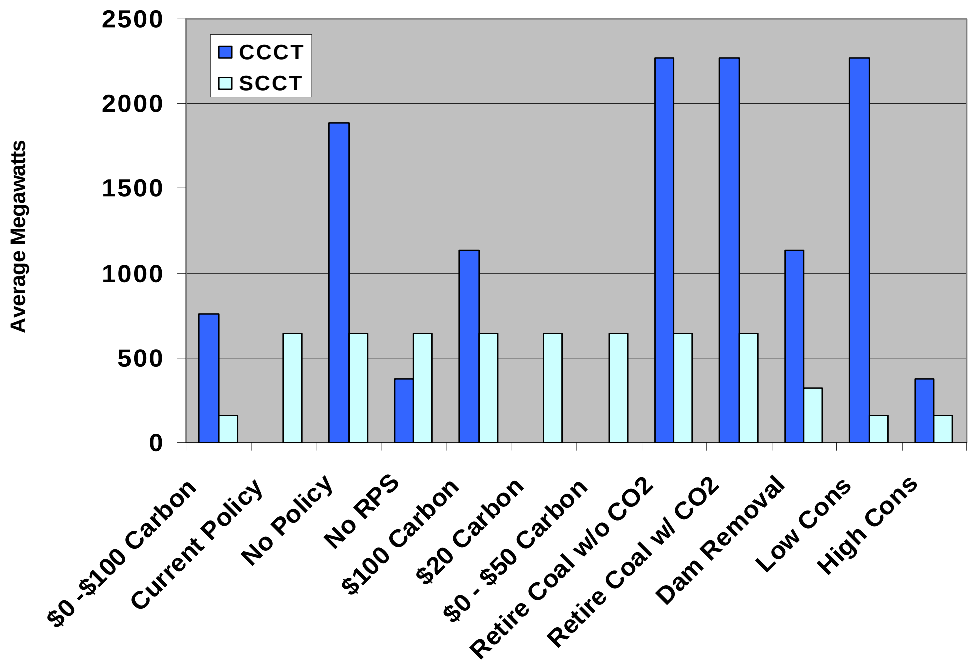
Natural Gas

There are two types of natural gas-fired generation considered in the RPM: simple-cycle turbines (SCCT) that are most suitable for providing peaking capacity, and combined-cycle turbines (CCCT) that are more suitable to providing base-load energy as well as peaking capacity.

While the amount of conservation and wind was fairly consistent across all scenarios examined, the future role of natural gas-fired generation is variable and specific to the scenarios studied. Figure 9-3 shows the average amounts of SCCT and CCCT optioned among the 750 futures considered in each scenario. The gas-fired plants are optioned (sited and licensed) so that they are available to develop if needed in each future. The actual amount of natural-gas fired generation constructed will vary in each future. For example, on average in the $0 - $100 Carbon scenario 162 average megawatts of CCCTs are optioned by the end of the planning period, but are constructed only in about 30 percent of the futures.

The optioning of CCCTs is largest when there is a need for energy. This occurs, for example, in scenarios that feature energy lost from other resources like the retirement of existing coal plants or reduced conservation achievements. Among these scenarios not only does the amount of gas-fired resources optioned vary, but the likelihood of completing the plants also varies.

Figure 9-3: Natural Gas-Fired Resource Options



The particular type of natural gas-fired generation optioned and added depends significantly on anticipated future conditions. Specific utility needs drive resource choices. For example, individual utilities may find their circumstances include need for within-hour balancing reserves, a system with differing capacity requirements, or limited access to market resources. All of these factors limit the ability of the regional resource strategy to be specific about optioning and construction dates for natural gas fired resources, or for the types of natural gas-fired generation.

Nevertheless, it is clear that after conservation and renewables, natural gas-fired generation is the most cost-effective resource option for the region in the near-term. Other resource alternatives may become available over time, and the Sixth Power Plan recommends actions to encourage expansion of the diversity of resources available.

CHARACTERISTICS OF SCENARIOS

The most important considerations for selecting a resource strategy are the cost, risk, and carbon emissions of the various scenarios considered. The measurement of these attributes was discussed in Chapter 8. Although the Council's resource strategy is based on the analysis of several different scenarios, a comparison of the characteristics of the scenarios provides important information about the value of conservation achievement and the cost and effectiveness of various carbon policy approaches.

This section summarizes the analysis results of the various scenarios the Council considered in developing its resource strategy. The tables provide information on average values over 750 futures for costs, carbon emissions, conservation acquisition, and wind development. The resource planning costs have been converted into estimated retail rates. These are presented as levelized rates over the planning period. It also provides the amounts of other generation that are optioned by the end of the planning period.

In many of the tables and discussions the different scenarios are compared to the $0 to $100 Carbon scenario. This scenario is chosen as a matter of convenience to illustrate the varying effects of the scenarios. The results of this scenario are also representative of the Council's resource strategy in terms of the amount of conservation and wind development recommended.

Conservation Scenarios

The Council's draft Sixth Power Plan includes significantly more conservation than previous Council plans. The conditions that led to this increase in cost-effective conservation are discussed in Chapter 4. In essence, conservation provides a low-cost resource to the power system that is without risk of increased fuel prices and carbon prices.

Two scenarios were developed to test the value of conservation to the power plan. Both scenarios were based on the $0 to $100 Carbon scenario assumptions with variations in the conservation assumptions. In the Low Conservation scenario, the amount of conservation was reduced from the $0 to $100 Carbon scenario by assuming that no more than 100 average megawatts per year of retrofit conservation could be developed, instead of 160 in the $0 to $100 Carbon scenario, and that lost-opportunity conservation ramp-up would take 20 years to reach 85 percent annual penetration, instead of 15 years used in the $0 to $100 Carbon scenario. The Low Conservation scenario only develops 800 average megawatts in the 5-year action plan period, compared to 1,200 average megawatts in the $0 to $100 Carbon scenario.

The second conservation scenario explores the effects of raising the assumption about conservation development. For this High Conservation scenario, the Council assumed it would take 10 years to develop the first 2,400 average megawatts of retrofit conservation, instead of the 15 years assumed in the $0 to $100 Carbon scenario. This equates to an average pace of 220 average megawatts per year for retrofit conservation, but no increase in the ramp-up for lost-opportunity conservation. In the High Conservation scenario, 1,500 average megawatts of conservation is developed over the first five years of the action plan.

Table 9-4 shows a summary of the results of the Low and High Conservation scenarios compared to the $0 to $100 Carbon scenario. The amount of conservation achieved in the Low Conservation scenario is reduced significantly. It is lower than the amount found cost effective in any of the carbon scenarios, including the No Policy scenario. However, the High Conservation scenario changes only slightly the amount of conservation achieved over the planning period. This is because the High Conservation scenario accelerates discretionary conservation. The total amount of conservation available does not change. In addition, the lost opportunity conservation was not changed for the High Conservation scenario.

The Low Conservation scenario results in a 4.4 million ton increase in average annual carbon emissions, but the High Conservation shows approximately the same level of carbon emissions as found in the $0 to $100 Carbon scenario.

Reduced conservation achievements in the Low Conservation scenario are made up for by increased gas-fired combined-cycle generation and more renewables. Three times as many combined-cycle combustion turbines are optioned in the Low Conservation scenario as in the $0 to $100 Carbon scenario. New renewable generation capability increases by 196 average megawatts.

Under the Low Conservation scenario, power system costs are increased by $5 billion in added resource acquisition costs and carbon penalties if conservation is developed at this limited level. If this scenario excludes any anticipated carbon penalties, limiting conservation achievement increases power system costs by $3.7 billion over the 20 years of the power plan. These changes are reflected in the first line of Table 9-4.

Not only is the power system more expensive if 1,000 megawatts of conservation is replaced with primarily gas-fired generation, risk is also increased. Although the average cost of the power system, including carbon penalties, increases by 8 percent in the Low Conservation scenario, the risk of the power system increases by 12 percent, from $155.5 to $173.9 billion. Risk is a measure of the average cost of the 75 highest cost futures. The increase in risk demonstrates the value of conservation in reducing the risk of futures that feature high carbon costs.

Table 9-1: Low and High Conservation Scenarios versus the $0 to $100 Carbon Scenario

	$0 to $100 Carbon	Low Conservation	High Conservation
Cost (billion 2006$ NPV)			
With Carbon Penalty	$105.60	$114.30	$103.80
Without Carbon Penalty	$85.10	$88.70	$84.80
Retail Rates - Change (%) from $0 to $100 Carbon Scenario			
With Carbon Penalty		- 1.4%	+ 0.6%
Without Carbon Penalty		- 2.4%	+ 0.9%
Carbon Emissions (Gen) (Million Tons/Year)	37.1	41.0	36.6
Resources 2030			
Conservation (MWa)	5,827	4,566	5,849
Wind (MWa)	1,800	1,996	1,778
Geothermal Options (MWa)	169	208	195
CCCT Options (MWa)	756	2268	378
SCCT Options (MWa)	162	162	162

The cost-effective level of conservation is consistent across each climate change scenario examined. The amount of conservation selected in the several climate change scenarios described in the previous section falls consistently between 5,000 and 6,000 average megawatts. Figure 9-1 illustrates this fact. Thus the importance of conservation in the Sixth Power Plan is not dependent on any particular view about climate change or specific climate change policies; it is a simple reflection of cost and risk. Risk associated with demand growth, water conditions, natural gas prices, and other uncertainties provide justification for conservation development even in the absence of carbon price risks.

Carbon Policy Scenarios

The discussion of the carbon policy scenarios first compares the No Policy and Current Policy scenarios to the $0 to $100 Carbon price risk scenario. Then other approaches to carbon pricing or other control policies are compared to the $0 to $100 Carbon scenario.

Current Policy Scenario

The Current Policy scenario tests the effect of only known, instituted carbon policies on the plan's resource strategy. As the name implies it includes current RPS requirements, new plant carbon dioxide performance standards, and renewable energy credits, but ignores the potential risk of carbon pricing policies in the future, as are being discussed by individual states, the WCI, and in proposed federal legislation.

This scenario shows that carbon emission levels of the regional power system could be stabilized with existing policies, but carbon emission reduction goals would not be achieved. Compared to the least-risk portfolio, as shown in table 9-2, future power system costs would be reduced by 17 percent compared to the $0 to $100 Carbon scenario if utilities are provided free emission allowances for most of the planning period. In this scenario, the effects on electricity retail rates would be very small. The cost reduction would be nearly one third larger if the carbon emissions allowances are assumed to be entirely auctioned in the $0 to $100 Carbon scenario, that is, if utilities had to pay the full cost of allowances. National policy proposals would provide free allowances to utilities for most of the planning period and therefore are much closer to the free allowance end of the range. Tables in this section show power system costs both with free allowances and with allowance costs paid entirely by the power system in scenarios that include carbon pricing policy.

Compared to the $0 to $100 Carbon portfolio the Current Policy scenario would develop less conservation and natural gas-fired combined-cycle generation would shift to simple-cycle turbines to provide capacity for integrating wind power into the regional power system. Because the Current Policy scenario does not include carbon pricing policy risk, the region's existing coal plants continue to provide base load energy for the power system, whereas in the $0 to $100 Carbon scenario coal plants are dispatched less to mitigate carbon costs. Table 9-5 compares the Current Policy scenario to the $0 to $100 Carbon scenario.

Table 9-2: The Current Policy versus the $0 to $100 Carbon Scenario

	Current Policy	$0 to $100 Carbon
Cost (billion 2006$ NPV)		
With Carbon Penalty	$70.50	$105.60
Without Carbon Penalty	$70.50	$85.10
Retail Rates - Change (%) from Current Policy		
With Carbon Penalty		+ 9.3%
Without Carbon Penalty		+ 2.4%
Carbon Emissions (Gen) (Million Tons/Year)	52.1	37.1
Resources 2030		
Conservation (MWa)	5,197	5,827
Wind (MWa)	1,845	1,800
Geothermal Options (MWa)	13	169
CCCT Options (MWa)	0	756
SCCT Options (MWa)	648	162

The figures for carbon emissions, conservation, and wind development are averages across all futures at the end of the study. The cost and rates without carbon penalty do not include the penalty applied to CO2 production. There is still an economic effect on the dispatch order of resources included in these costs.

No Policy Scenario

One question the Council has been asked to address is: what will be the cost of reducing carbon emissions from the power system? To address that question a scenario was developed that excluded not only the risk of potential future carbon pricing penalties, but also excluded the RPS requirements, new plant carbon dioxide performance standards, and RECs. However, this No Policy scenario did not assume that new pulverized coal plants would be available for development.

Table 9-3 compares the result of the No Policy scenario to both the Current Policy and $0 to $100 Carbon scenarios. Costs of the power system would be increased from $56.5 billion in the No Policy scenario to $70.5 billion with Current Policy, and to $85.1 billion in the $0 to $100 Carbon scenario. The $0 to $100 Carbon scenario increases the cost of the regional power system by 50 percent compared to a scenario that ignores current climate policy and potential future climate policy risks. If carbon penalties were borne by the power system, the cost increases associated with addressing climate policy would be greater. In that case, the power system costs in the $0 to $100 Carbon scenario would be nearly double to cost of the No Policy scenario. The effect on retail rates is an increase of between 5 and 12 percent on average over the planning period depending on whether or not carbon penalties are included in utility costs.

In the absence of any climate policy, carbon emissions would continue to grow. By 2030 carbon emissions from the power system would increase by 5 percent over 2005 levels. Interestingly, under the No Policy scenario, the amount of conservation that is developed is smaller than the $0 to $100 Carbon scenario but more than that developed under the Current Policy scenario. However, no new renewable resources are developed in the No Policy scenario except for a small amount of geothermal; and a large amount of natural gas-fired resources are added. Table 9-3 summarizes the comparison.

Table 9-3: The No Policy Scenario Versus the Current Policy and $0 to $100 Carbon Scenarios

	No Policy	Current Policy	$0 to $100 Carbon
Cost (billion 2006$ NPV)			
With Carbon Penalty	$56.50	$70.50	$105.6
Without Carbon Penalty	$56.50	$70.50	$85.10
Retail Rates - Change (%) from No Policy Scenario			
With Carbon Penalty		+ 2.8%	+ 12.3%
Without Carbon Penalty		+ 2.8%	+ 5.3%
Carbon Emissions (Gen) (Million Tons/Year)	60.0	52.1	37.1
Resources 2030			
Conservation (MWa)	5,432	5,197	5,827
Wind (MWa)	0	1,845	1,800
Geothermal Options (MWa)	52	13	169
CCCT Options (MWa)	1,890	0	756
SCCT Options (MWa)	648	648	162

No Renewable Portfolio Standards

Three of the four states in the region have some form of renewable portfolio standard that requires a certain share of electricity consumption to be supplied from qualifying renewable generation. This policy favors one particular solution to carbon emissions, but encourages development of new forms of electricity generation. Questions the Council considered were whether an RPS would be necessary if there is a perceived risk that a substantial carbon penalty could be imposed in the future, and whether other policies might be as effective in reducing carbon emissions. To explore this question, a scenario was run that removed RPS requirements from the $0 to $100 Carbon scenario.

Table 9-4 compares the results of the $0 to $100 Carbon scenario and the No RPS scenario. The results show only a small effect from the additional effect of RPS on the cost of the least-cost, low-risk resource portfolio. Cost is slightly lower without the RPS, and carbon emissions are higher. Significantly less renewable generation is developed, more conservation is acquired and more natural gas-fired generation is optioned in the No RPS scenario.

Table 9-4: The No RPS Scenario versus the $0 to $100 Carbon Scenario

	$0 to $100 Carbon	No RPS
Cost (billion 2006$ NPV)		
With Carbon Penalty	$105.60	$101.40
Without Carbon Penalty	$85.10	$79.30
Retail Rates - Change (%) from $0 to $100 Carbon Scenario		
With Carbon Penalty		- 1.2%
Without Carbon Penalty		- 1.7%
Carbon Emissions (Gen) (Million Tons/Year)	37.1	40.3
Resources 2030		
Conservation (MWa)	5,827	5,935
Wind (MWa)	1,800	1,171
Geothermal Options (MWa)	169	208
CCCT Options (MWa)	756	378
SCCT Options (MWa)	162	648

This scenario indicates that RPS requirements make an additional contribution to meeting carbon targets at a modest cost. RPS is a policy that can be, and has been, put in place to move the region toward a lower carbon future while other policy solutions are being developed at the national, regional, and state level. These potential future policies can have an effect on resource decisions even though they are not yet enacted because of the risk they pose for future carbon penalties. Unfortunately one of those effects may be to delay needed resource decisions because of the uncertainty. A similar situation occurred in the mid-1990s. Fear that federal policy would restructure the electric industry caused utilities to delay resource development decisions, which eventually led to an inadequate power system and the 2000-01 electricity crisis.

Retiring Existing Coal Plants

Existing coal plants account for over 85 percent of power system carbon emissions in the Pacific Northwest. Therefore any significant reduction in carbon emissions from the power system must include reduced operation of these power plants. In the $0 to $100 Carbon scenario, the ability to reduce carbon emissions to below 1990 levels results partly from coal plants being displaced in favor of renewable generation and conservation. In futures with high-carbon costs, natural gas plants become lower in cost than coal and as a result coal is dispatched less often.

If coal plants are dispatched less but remain available to run under some future conditions, carbon emissions become more variable. When low-carbon prices are assumed for a future, the coal plants will operate and they may operate more when water conditions are low or demand is high. As a result, reduced carbon emissions are not assured even though they are lower on an expected or average basis. There are also questions about the viability of continued operation of these plants if they are used infrequently or at minimum capacity. It may be unrealistic to expect coal plants to run as natural gas plants currently do. Coal plants are less flexible and have higher fixed operating and maintenance costs.

An alternative approach was considered in two coal retirement scenarios. It was assumed that the regional coal plants are phased out between 2012 and 2020. They could be retired or mothballed, but they are not considered available to meet loads and their output must be replaced with other resources. The two Retire Coal scenarios are distinguished by two different assumptions regarding the existence of carbon pricing policies, with carbon penalties and without carbon penalties. Table 9-5 shows the results of these scenarios compared to the $0 to $100 Carbon scenario.

Table 9-5: The Retire Coal Scenarios versus the $0 to $100 Carbon Scenario

	$0 to $100 Carbon	Retire Coal w/ CO2	Retire Coal w/o CO2
Cost (billion 2006$ NPV)			
With Carbon Penalty	$105.60	$122.20	$94.70
Without Carbon Penalty	$85.10	$109.70	$94.70
Retail Rates - Change (%) from $0 to $100 Carbon Scenario			
With Carbon Penalty		+ 4.7%	- 0.4%
Without Carbon Penalty		+ 8.0%	+ 6.2%
Carbon Emissions (Gen) (Million Tons/Year)	37.1	14.7	14.0
Resources 2030			
Conservation (MWa)	5,827	6164	5,739
Wind (MWa)	1,800	1,787	1,809
Geothermal Options (MWa)	169	156	52
CCCT Options (MWa)	756	2268	2268
SCCT Options (MWa)	162	648	648

The retirement of the coal plants results in a dramatic reduction of carbon emissions. In 2030 the average emissions are reduced by 70 percent from 2005 levels. These reductions are approaching some of the targets proposed by the Intergovernmental Panel on Climate Change for 2050.

In the scenario where coal plants retirement is treated as a substitute for carbon pricing policy (Retire Coal without CO2), costs are decreased compared to the $0 to $100 Carbon scenario without free allowances. However, if coal is retired in combination with carbon pricing policy (Retire Coal with CO2) and free allowances are not granted, the power system costs increase by 16 percent. In rough terms, these cost increases would translate into real (without general economic inflation) average retail electricity price increases of 6 and 8 percent with free allowances.

The amounts of conservation acquired change moderately under each of these scenarios. The bulk of the coal capability is replaced by additional options on combined-cycle gas-fired generation, which has about 38 percent of the carbon emissions of an existing coal plant.

Like the RPS, a policy of retiring coal plants is an alternative carbon control policy. It also focuses on one particular solution without creating wide-spread incentive to find creative and low-cost solutions to reducing carbon emissions in every sector that produces carbon. Nevertheless, the results are more predictable and the policy could be implemented through regulations at the state level. It could be a viable alternative in a region like the Pacific Northwest where coal is not the dominant power supply, but is the dominant carbon emissions source. Replacement by natural gas is the alternative assumed here, but in the longer term other options may become available such as carbon capture and sequestration, advanced nuclear, or additional renewable generation technologies.

Fixed Carbon Price Scenarios

The $0 to $100 Carbon scenario assumes risk associated with an uncertain carbon pricing policy in the future. One question posed is: would the plan resource strategy change if a fixed carbon price were assumed? Two scenarios were tested: one with a $100 per ton carbon price and one with a $20 a ton carbon price. These scenarios generally cover the range of prices used in utility and other analyses. Table 9-6 shows the results of these two scenarios compared to the $0 to $100 Carbon scenario.

Table 9-6: The Fixed Carbon Price Scenarios versus the $0 to $100 Carbon Scenario

	$0 to $100 Carbon	$100 Carbon	$20 Carbon
Cost (billion 2006$ NPV)			
With Carbon Penalty	$105.60	$143.70	$89.70
Without Carbon Penalty	$85.10	$97.40	$72.30
Retail Rates - Change (%) from $0 to $100 Carbon Scenario			
With Carbon Penalty		+ 14.3%	- 2.1%
Without Carbon Penalty		+ 7.1%	- 1.0%
Carbon Emissions (Gen) (Million Tons/Year)	37.1	26.1	43.5
Resources 2030			
Conservation (MWa)	5,827	6,025	5,427
Wind (MWa)	1,800	1,790	1,808
Geothermal Options (MWa)	169	156	156
CCCT Options (MWa)	756	1134	0
SCCT Options (MWa)	162	648	648

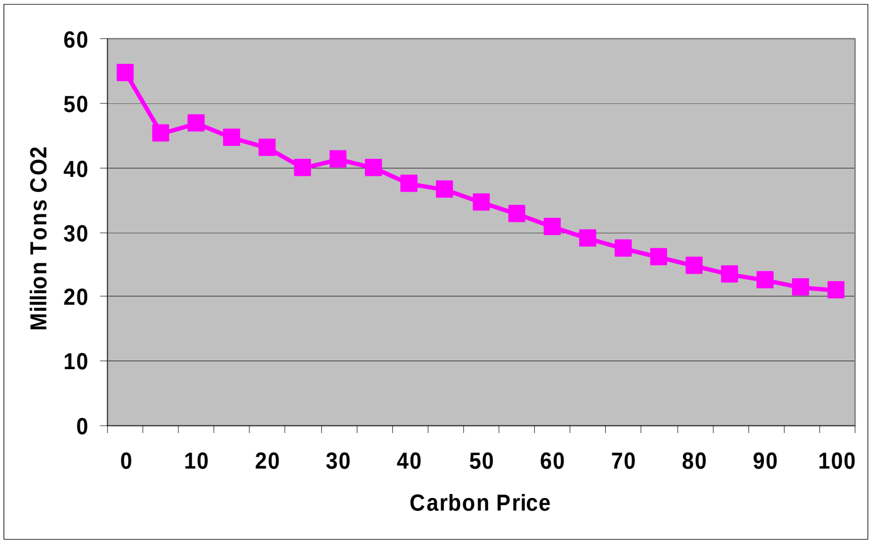
As would be expected, the $100 Carbon scenario reduces average carbon emissions far more than does the $0 to $100 Carbon scenario, which has an average carbon price that only reaches $47 per ton by 2030. The $20 carbon cost does not achieve these substantial reductions. Conservation does not increase substantially with $100 carbon costs because most of the available conservation was developed in the $0 to $100 Carbon scenario. There is a 400 average megawatt (7 percent) reduction of conservation in the $20 scenario. The development of renewable generation changes little among these scenarios and is largely determined by RPS requirements.

An interesting result is apparent in the changes of natural gas-fired generation options. With fixed carbon prices of $100 there is a large increase in the optioning of natural gas combined-cycle turbines, whereas with fixed $20 carbon costs more simple-cycle turbines are optioned. In the $100 Carbon scenario significant reductions in carbon emissions are achieved by displacing existing coal plants. The combined-cycle plants are being optioned to provide base-load energy and capacity to displace the coal plants. In the $20 Carbon Cost scenario the coal plants remain viable base-load plants and additional capacity is provided by simple-cycle turbines to provide capacity. In the $100 Carbon scenario, the question again arises of whether coal plants would remain viable at low-capacity operations.

These results are consistent with preliminary estimates done by the Council of carbon emissions using the AURORA$^{xmp®}$ Electric Market Model. The results of those studies showed that carbon prices of between $40 and $70 per ton are required to change the dispatch order of coal and natural gas-fired generation. The exact point of change will depend on the price of natural gas relative to the carbon price and will vary for individual plants. The future price of natural gas and carbon costs cannot be known. The $0 to $100 Carbon scenario, therefore, models the risks of alternative futures for both carbon cost and natural gas price to find a resource strategy that reduces the risk associated with these uncertainties.

Another approach to the question of how carbon prices are related to emission levels was done using the Regional Portfolio Model in a deterministic mode (i.e. using expected values of variables instead of stochastic analysis). The $0 to $100 Carbon scenario resource strategy was tested with costs for carbon emissions varying in $5 increments from $0 to $100. Figure 9-4 shows the results. Increasing carbon costs lead to reduced emissions. Again prices of carbon above $40 per ton begin to push carbon emissions below 40 million tons by 2030, and emissions could be cut in half from that level with institution of a carbon cost of $100 per ton. These results should not be expected to match closely the results for the $0 to $100 Carbon scenario in the tables in this section because of the effects of varying levels of demand, natural gas prices, hydro conditions, and other varying future conditions modeled in the $0 to $100 Carbon scenario.

Figure 9-4: An Estimated Relationship between Carbon Price and Emissions



Random Carbon Penalty up to $50

If a cap and trade system is implemented, the price of carbon emission permits will be determined in a market with multiple buyers and sellers. The price in that market will depend on the demand for allowances and the cost of reducing carbon emissions. Although there are estimates of the future cost of carbon emission allowances under the proposed Waxman Markey Bill, the actual costs experienced will depend on supply of and demand for allowances and on the role and geographic scope of any offsets that may be allowed to meet carbon reduction requirements.

To test this, the Council looked at a scenario where carbon prices could vary from $0 to $50 instead of the range of $0 to $100 assumed in the $0 to $100 Carbon scenario. The expected value of this smaller range of prices by 2030 is about $20 compared to the $47 average in the $0 to $100 Carbon scenario. Table 9-7 compares the results of the two carbon price risk scenarios.

Table 9-7: The $0 to $50 Carbon Scenario versus the $0 to $100 Carbon Scenario

	$0 to $100 Carbon	$50 CO2 Price Maximum
Cost (billion 2006$ NPV)		
With Carbon Penalty	$105.60	$91.60
Without Carbon Penalty	$85.10	$78.30
Retail Rates - Change (%) from $0 to $100 Carbon Scenario		
With Carbon Penalty		- 3.6%
Without Carbon Penalty		- 1.0%
Carbon Emissions (Gen) (Million Tons/Year)	37.1	41.7
Resources 2030		
Conservation (MWa)	5,827	5,638
Wind (MWa)	1,800	1,798
Geothermal Options (MWa)	169	156
CCCT Options (MWa)	756	0
SCCT Options (MWa)	162	648

With a lower carbon price range, the cost of the power system is less, especially when carbon emission allowance costs are included in the costs. However, the costs that result from different resource choices and operations are only reduced by 8 percent. Carbon emissions are increased about 12 percent.

Most importantly, the Power Plan's basic resource strategy is not significantly changed by the lower carbon price range. Conservation remains the dominant resource choice, renewable development is driven by RPS requirements and does not change significantly, and natural gas remains the fuel-based resource for other needs.

Value of the Hydroelectric System

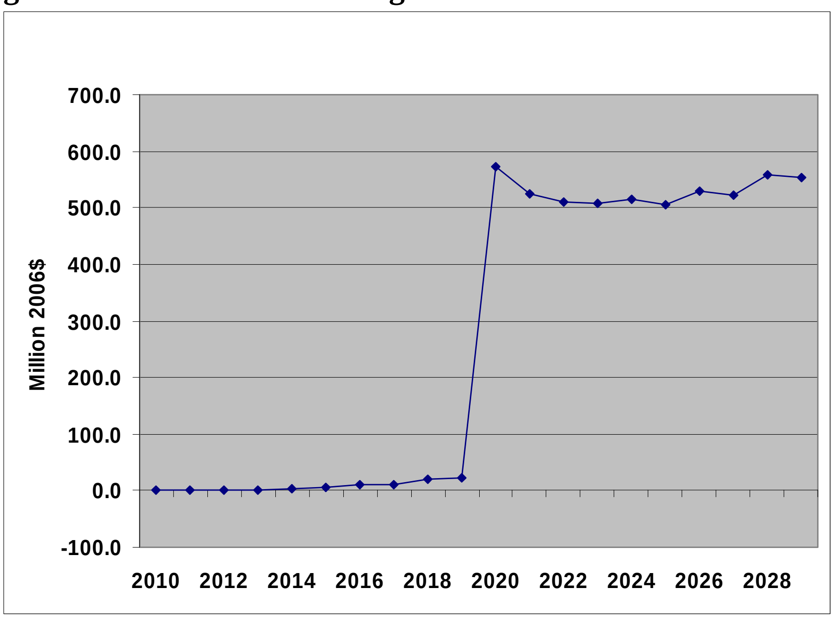
The Pacific Northwest power system emits about half the carbon dioxide per kilowatt-hour of the nation or the rest of the western states. This is due to the large role played by the hydroelectric system of the region. The value of this system is sometimes overlooked. To illustrate this tradeoff a scenario was run to examine the effects of removing the lower Snake River dams on costs, carbon emissions, and replacement resources that would be required for the power system. The capability of the dams was removed from the $0 to $100 Carbon scenario. The results of the scenario, however, could apply to other changes that reduce the capability of the hydroelectric system for any reason. For this scenario, it was assumed that the dams are removed in 2020 and the energy and capacity are replaced by the Regional Portfolio Model. The results are compared to the $0 to $100 Carbon scenario in Table 9-8.

Table 9-8: The Dam Removal Scenario versus the $0 to $100 Carbon Scenario

	$0 to $100 Carbon	Dam Removal
Cost (billion 2006$ NPV) With Carbon Penalty Without Carbon Penalty	 $105.60 $85.10	 $112.50 $88.80
Retail Rates - Change (%) from $0 to $100 Carbon Scenario With Carbon Penalty Without Carbon Penalty		 + 1.7% + 1.0%
Carbon Emissions (Gen) (Million Tons/Year)	37.1	40.2
Resources 2030		
Conservation (MWa)	5,827	5,923
Wind (MWa)	1,800	1,801
Geothermal Options (MWa)	169	208
CCCT Options (MWa)	756	1134
SCCT Options (MWa)	162	324

Dam removal increases both the carbon emissions and cost of the power system. Small increases in conservation and renewable resources occur in this scenario, but the primary replacement of the dams is provided by natural gas-fired combined-cycle combustion turbines. Figure 9-5 shows the annual pattern of cost changes for the Dam Removal scenario. Annual cost of the power system increases in 2020 by about $550 million dollars and remains higher.

Figure 9-5: Annual Cost Changes for the Dam Removal Scenario



Summary

Figure 9-6 summarizes the results of the various scenarios described above. Significantly reducing carbon emissions from the regional power system will increase costs of electricity. The costs shown in this summary assume that carbon penalties are excluded from utility revenue requirements through free emission allowances or other mitigation. The Current Policies scenario demonstrates the region can stabilize emissions near 2005 levels by 2030, but not reduce them without additional actions aimed at reducing carbon emissions. Without the current policies in place now, however, carbon emissions from the power system would continue to grow. Because over 85 percent of these carbon emissions are from existing coal plants serving regional loads, any significant reduction requires reduced reliance on these coal plants. Carbon prices above $40 per ton can reduce coal plant use, but an alternative policy would be to retire coal plants. In either scenario, the future cost of electricity would be increased.

Another way of looking at these results is to compare scenarios in terms of changes relative to the $0 to $100 Carbon scenario. Figure 9-7 shows changes in net present value system costs as bars and changes in carbon emissions as diamonds measured from the left hand scale. There is only one scenario in which costs and carbon emissions move in the same direction. That is the Dam Removal scenario where the policy choice is not intended to reduce carbon emissions, but rather to improve salmon and steelhead survival.

Figure 9-6: Summary of Costs and CO2 Emissions in Climate Policy Scenarios

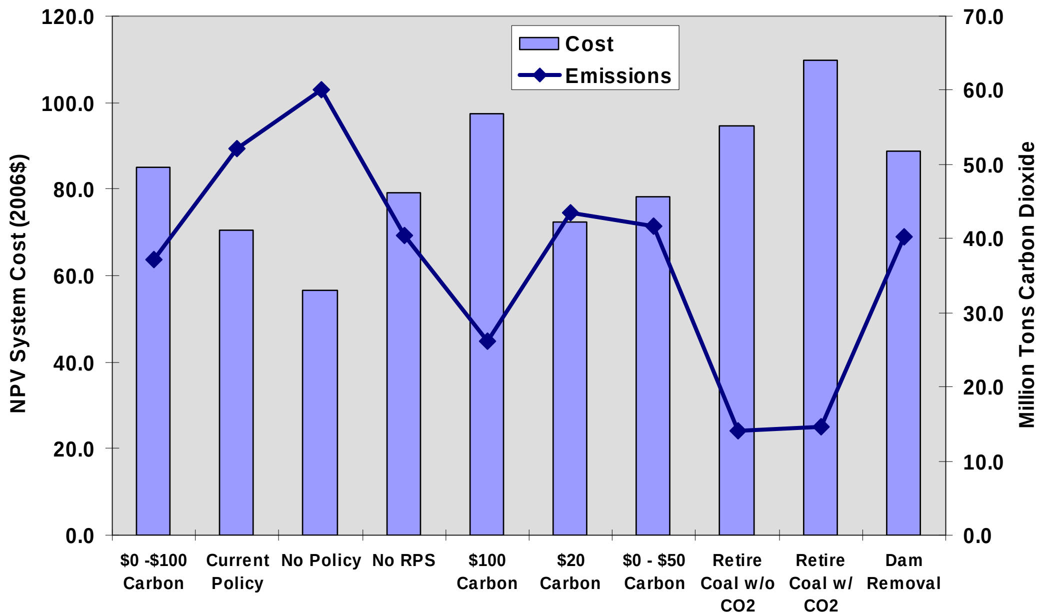
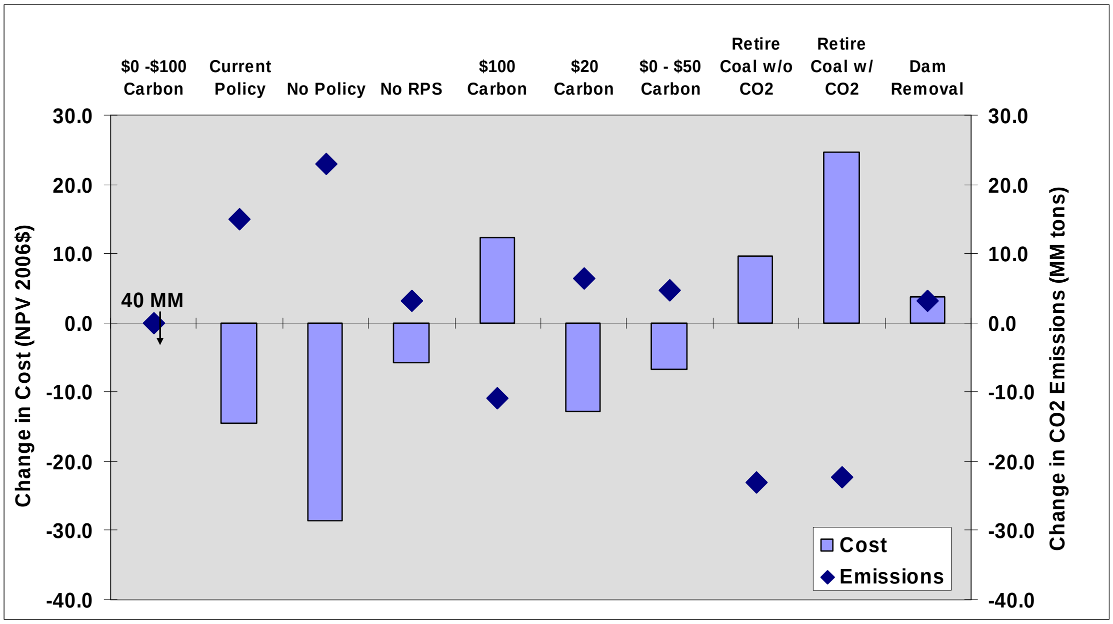


Figure 9-7: Summary of Costs and CO2 Emissions: Changes from $0 to $100 Carbon Scenario



Consumer Electric Rates and Monthly Bills

The net present value system costs that are the basis for resource planning do not mean a great deal to the region's citizens. They are more likely to be interested in their monthly electricity bills or the electricity rates that they pay. In this section, the effects of the various scenarios used to develop the Council's resource strategy for the Sixth Power Plan on consumers bills and rates are discussed.

By law, the Council's Power Plan is to minimize the cost of energy services, such as heat or light. The Council is not charged with minimizing electricity rates. The objective of the Plan is to minimize consumers' electric bills. There are a number of steps involved in estimating rates or bills from the going forward system costs that are the planning criteria for the Council's Plan. Most notably, the fixed cost of the existing power system must be recovered through rates (paid for in bills) but is not included in the system costs of the Council models. In addition, some of the costs of conservation are not paid through electricity bills, but are paid directly by consumers. For example, an energy efficiency standard will improve the efficiency of appliances and to the extent it results in higher cost appliances, consumers will pay for the increased efficiency directly, rather than through electricity bills. There are other adjustments as well. For example, as described in Chapter 8, it is not clear what amount of any carbon tax or carbon emissions allowance cost will have to be recovered through electricity rates.

The Council has calculated costs, rates and bills including both all and none of these carbon penalty costs to provide a range of effects. From a societal perspective someone will pay these costs to reduce carbon emissions, but it isn't clear how much of the reduction will be accomplished in the electricity sector, nor how much will show up in bills and rates.

In the rates and bills calculations in this section, the fixed cost of the existing power system is assumed to remain constant in real terms. Depreciation of existing assets is assumed to be offset by equipment upgrades and replacements. To the extent that major transmission upgrades are needed in the future, these costs are not included in these estimates. Those costs are likely to occur regardless of the resources chosen for the Council's resource strategy, although aggressive conservation will reduce the need for additional transmission along with reducing the need for new electricity generation capability. One exception is the cost of upgrading transmission to access remote wind resources; these costs are recognized in the Council's planning.

Figure 9-8 shows a comparison of electricity rates among the scenarios considered in the Plan. The rates are shown both with and without the carbon penalties. The variation in rates is not as large as the variation shown earlier in power system planning costs. That is because a large portion of the revenue requirement that has to be recovered in rates and bills is fixed and does not change among the scenarios. It is important to remember that these rates are averages over 750 futures. There will be very significant variations among these futures depending on natural gas prices, hydroelectric conditions, the need to build new generation, and electricity market prices.

Another reason for relatively little variation in rates is the fact that conservation accounts for the majority of new resources. The low and high conservation scenarios show that the effect on electricity rates is not large. Conservation does tend to raise the rates for electricity, but as can be seen in Figure 9-9 it reduces electricity bills because less electricity is used.

The $0 to $100 Carbon scenario is one that is estimated to attain on average the carbon reduction goals in Oregon and Washington and in proposed federal legislation. It is therefore interesting to examine the estimated rate and bill effects of that scenario compared to the Current Policy scenario. The implicit assumption in these comparisons is that the electricity sector would be required to meet a similar percent reduction in emissions as the economy at large. The rates in the $0 to $100 Carbon scenario are between 2.4 percent and 9.3 percent higher than the Current Policy scenario. The range depends on how much of the carbon penalty has to be recovered through electricity sale revenues. The effect on electricity bills is to increase average monthly bills for a residential consumer by between $.94 and $5.58.

The largest effect on bills and rates is in the fixed $100 Carbon scenario. The second largest effect is in the coal retirement scenarios. Unless replacement of existing coal-fired generation is subsidized in such a policy scenario, the cost would be expected to be recovered through electricity revenues.

Figure 9-8: Levelized Retail Rates in Alternative Scenarios

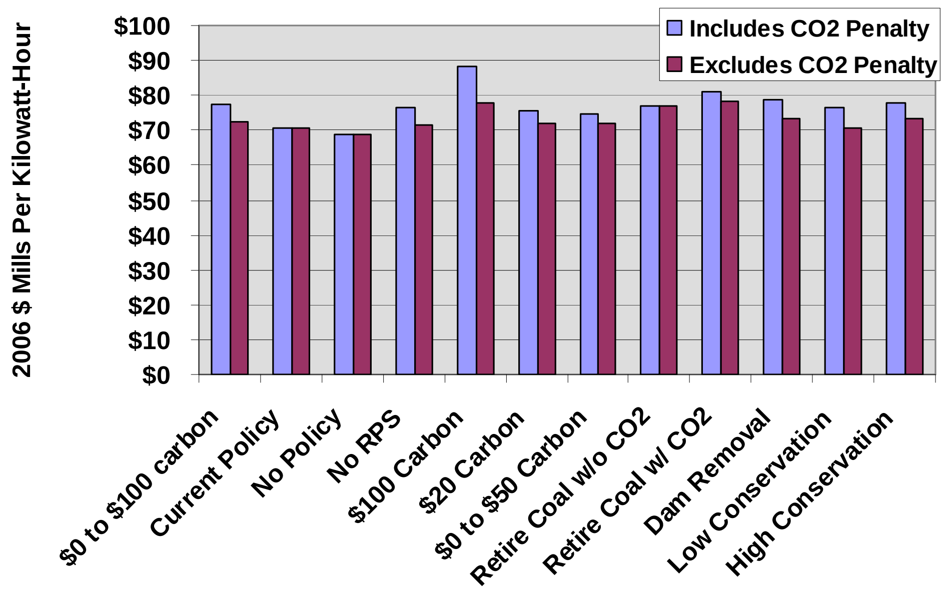


Figure 9-9: Levelized Residential Monthly Electricity Bills in Alternative Scenarios

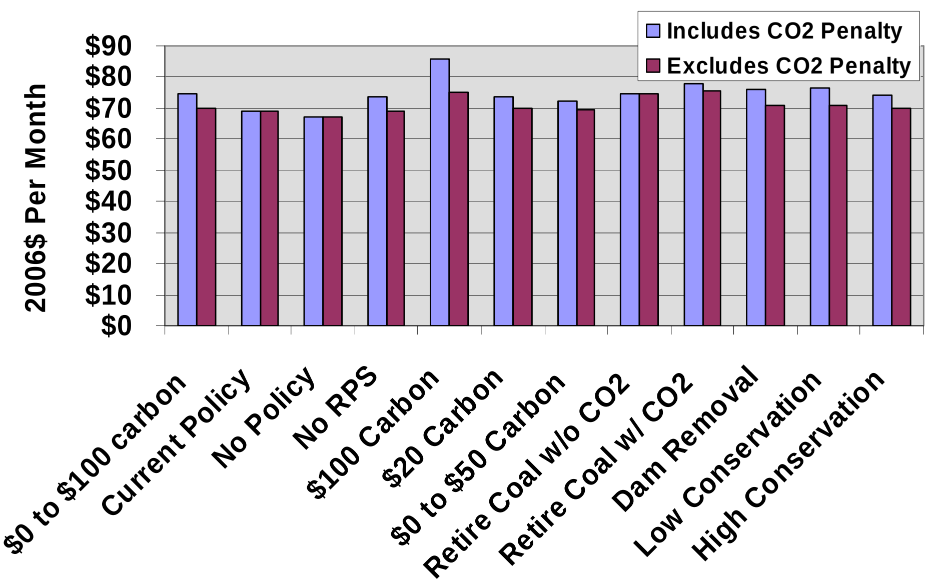


Figure 9-10 shows forecasts of monthly residential electricity bills over time for three scenarios; No Policy, Current Policy, and the $0 to $100 Carbon price risk assessment scenario. The $0 to $100 Carbon scenario bills are shown both with and without carbon costs included in the rates. This graph illustrates that attaining significant carbon reductions will increase electricity rates and bills. Without carbon price risk in the Current Policy scenario average bills would remain about the same over time. In the $0 to $100 Carbon scenario bills would be expected to increase by about 0.8 percent per year during the planning period if cost penalties are included. In the same scenario electricity rates would increase by 1.2 percent per year.

The increases seem small relative to some of the changes in planning costs. The effects of carbon pricing are minimized by the large role of conservation and renewables in the plan and the fact discussed above that a large share of electricity bills goes to cover existing infrastructure costs that are assumed not to change. In addition, a carbon penalty impacts the Pacific Northwest less than other regions because of the large role of our hydroelectric system and limited reliance on coal-fired generation.

Figure 9-10: Monthly Residential Electric Bills in Three Scenarios

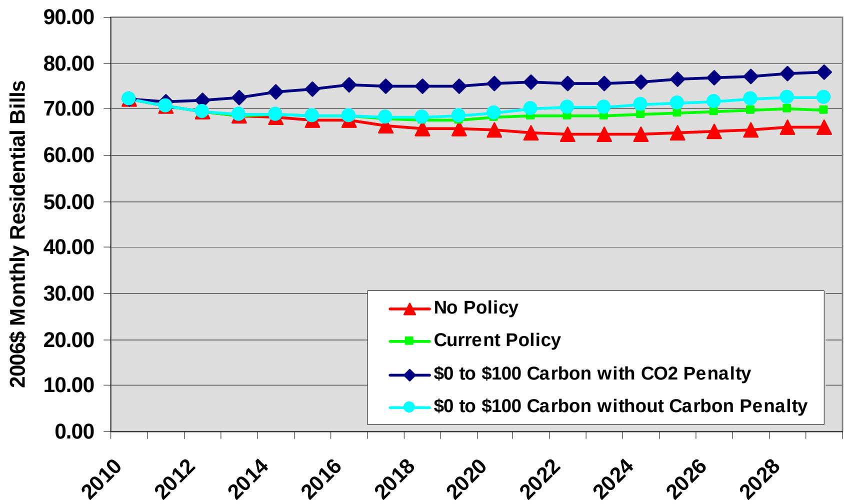
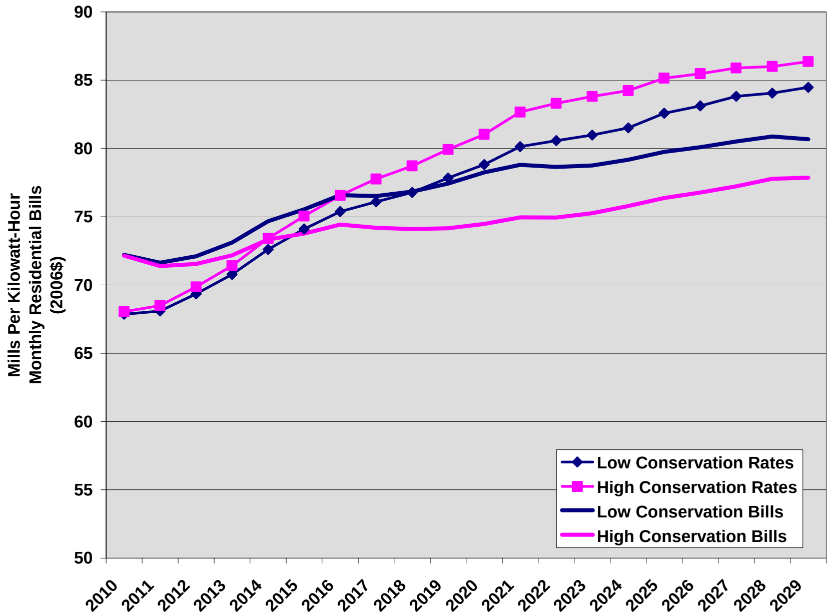


Figure 9-11 illustrates the effect of conservation costs on rates and bills. Conservation imposes cost on the power system, but reduces electricity sales. To recover the costs, therefore, utilities are required to raise electricity rates per kilowatt-hour. At the same time, however, consumers' use of electricity decreases. The net effect is that on average, consumers' monthly electricity bills are reduced. This is illustrated in Figure 9-11 by comparing rates and bills between the Low Conservation scenario and the High Conservation scenario. With low conservation, rates are reduced but bills are increased.

Figure 9-11: Electric Rate and Bill Effects of Low and High Conservation Scenarios



Detailed Scenario Results

The table below summarizes the most important results from the scenario analyses. It includes information of the costs, retail rates, carbon emissions, and resource choices. The differences between the Current Policy (Zero Carbon Risk) and other scenarios are calculated. In addition, for rates alternative scenarios are compared to both the Current Policy scenario and the $0 to $100 Carbon scenarios.

Scenario Comparison	No Policy	Zero Carbon Risk Current Policy	$0 to $50 Carbon risk	$0 to $100 Carbon risk	No RPS	Retire Coal with CO2	Retire Coal w/o CO2	$100 Carbon	$20 Carbon	Dam Removal	High Conservation	Low Conservation
Cost (billion 2006$ NPV) **with** Carbon Penalty	$56.5	$70.5	$91.6	$105.6	$101.4	$122.2	$94.7	$143.7	$89.7	$112.5	$103.8	$114.3
NPV Change from Current Policy	-$14.0	$0.0	$21.1	$35.1	$30.9	$51.7	$24.2	$73.2	$19.2	$42.0	$33.3	$43.8
% Change from Current Policy	-20%	0%	30%	50%	44%	73%	34%	104%	27%	60%	47%	62%
Cost (billion 2006$ NPV) **without** Carbon Penalty	$56.5	$70.5	$78.3	$85.1	$79.3	$109.7	$94.7	$97.4	$72.3	$88.8	$84.8	$88.7
NPV Change from Current Policy	-$14.0	$0.0	$7.8	$14.6	$8.8	$39.2	$24.2	$26.9	$1.8	$18.3	$14.3	$18.2
% Change from Current Policy	-20%	0%	11%	21%	12%	56%	34%	38%	3%	26%	20%	26%
Retail Rates - **with** Carbon Penalty	68.87	70.80	74.60	77.37	76.48	80.97	77.03	88.44	75.78	78.70	77.83	76.28
% Change from $0 to $100 Carbon Risk	-11.0%	-8.5%	-3.6%	0.0%	-1.2%	4.7%	-0.4%	14.3%	-2.1%	1.7%	0.6%	-1.4%
% Change from Zero Carbon Risk	-2.7%	0.0%	5.4%	9.3%	8.0%	14.4%	8.8%	24.9%	7.0%	11.2%	9.9%	7.7%
Retail Rates - **without** Carbon Penalty	68.87	70.80	71.78	72.51	71.30	78.28	77.03	77.68	71.79	73.21	73.17	70.75
% Change from $0 to $100 Carbon Risk	-5.0%	-2.4%	-1.0%	0.0%	-1.7%	8.0%	6.2%	7.1%	-1.0%	1.0%	0.9%	-2.4%
% Change from Zero Carbon Risk	-2.7%	0.0%	1.4%	2.4%	0.7%	10.6%	8.8%	9.7%	1.4%	3.4%	3.3%	-0.1%
Carbon Emissions Comparison												
Carbon Emissions (Gen) (Millions Tons/year)	60	52.1	41.7	37.1	40.3	14.7	14	26.1	43.5	40.2	36.6	41
Millions of tons Saved Compared to Current Case over 20 yrs.	-158	0	208	300	236	748	762	520	172	238	310	222
Resources 2030												
Conservation (MWa)	5,432	5,197	5,638	5,827	5,935	6164	5,739	6,025	5,427	5,923	5,849	4,566
Wind (MWa)	0	1,845	1,798	1,800	1,171	1,787	1,809	1,790	1,808	1,801	1,778	1,996
Geothermal Options (MW)	52	13	156	169	208	156	52	156	156	208	195	208
CCCT Options (MW)	1890	0	0	756	378	2268	2268	1134	0	1134	378	2268
SCCT Options (MW)	648	648	648	162	648	648	648	648	648	324	162	162