CHAPTER 15: ANALYSIS OF ALTERNATIVE RESOURCE STRATEGIES

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KEY FINDINGS

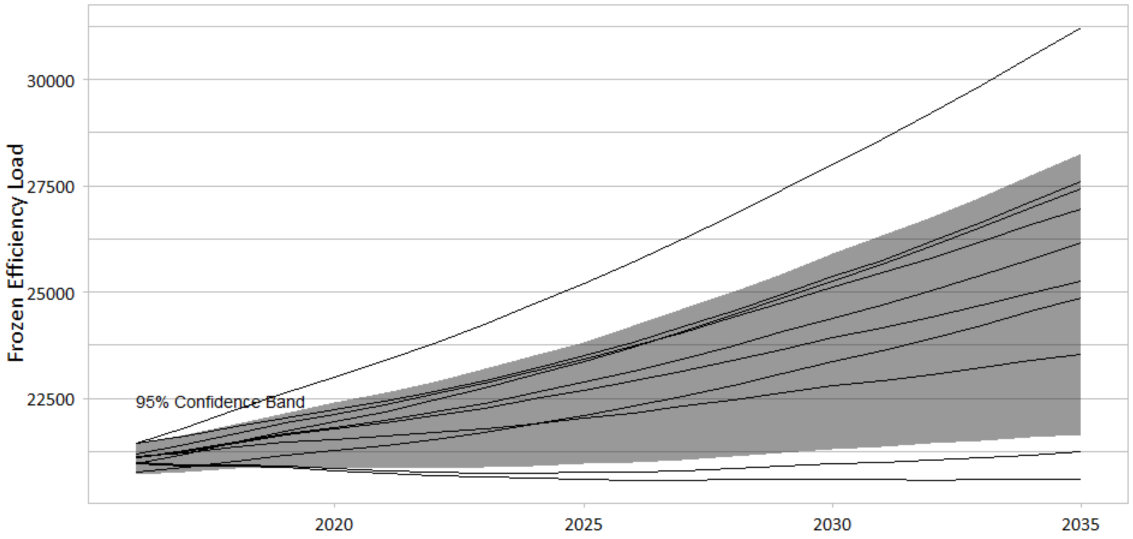
UNCERTAINTY ABOUT THE FUTURE

The future is uncertain, that impacts the costs and risk of selecting resources to generate power. To analyze different resource strategies, estimating the uncertainty is an essential first step. The primary uncertainties examined by the Council's Regional Portfolio Model (RPM) are the demand for electricity, the generation from the hydroelectric system, market prices for both electricity and natural gas, and CO2 policy. Each of these is discussed below.

Demand for Electricity

One of the uncertainties faced by the region is how much electricity will be needed in the future. The Council creates a forecast that estimates a range of potential future conditions that is detailed in Chapter 8. To analyze the impact of this uncertainty on alternative resource strategies, the range is translated into 800 "potential futures". Details of how these futures are developed are covered in appendix L on the Regional Portfolio Model (RPM). Because conservation is part of developing the resource strategy, these futures intentionally exclude any future conservation. These are then used in evaluating the impact of a resource strategy. Figure 15-1 shows a sample of the 800 futures considered when analyzing resource strategies.

Figure 15 - 1: Example of forecast potential future demand for electricity



Hydroelectric Generation

Generation from the hydroelectric system is also uncertain. The method the Council uses for estimating the impact of that uncertainty is to use historic streamflows and estimate the resulting generation through the current hydroelectric system.

An 80-year history of streamflows and generation provides the basis for hydropower generation in the model. The hydropower generation reflects constraints associated with the NOAA Fisheries 2008 biological opinion. Moreover, scenarios evaluate resource choices assuming no emergency reliance on the hydropower system, even though such reliance might not violate 2008 biological opinion constraints.

In addition to meeting fish and wildlife requirements, hydropower operation must satisfy other objectives. These objectives include standard flood control, river navigation, irrigation, recreational, and refill requirements. All scenarios incorporate these constraints.

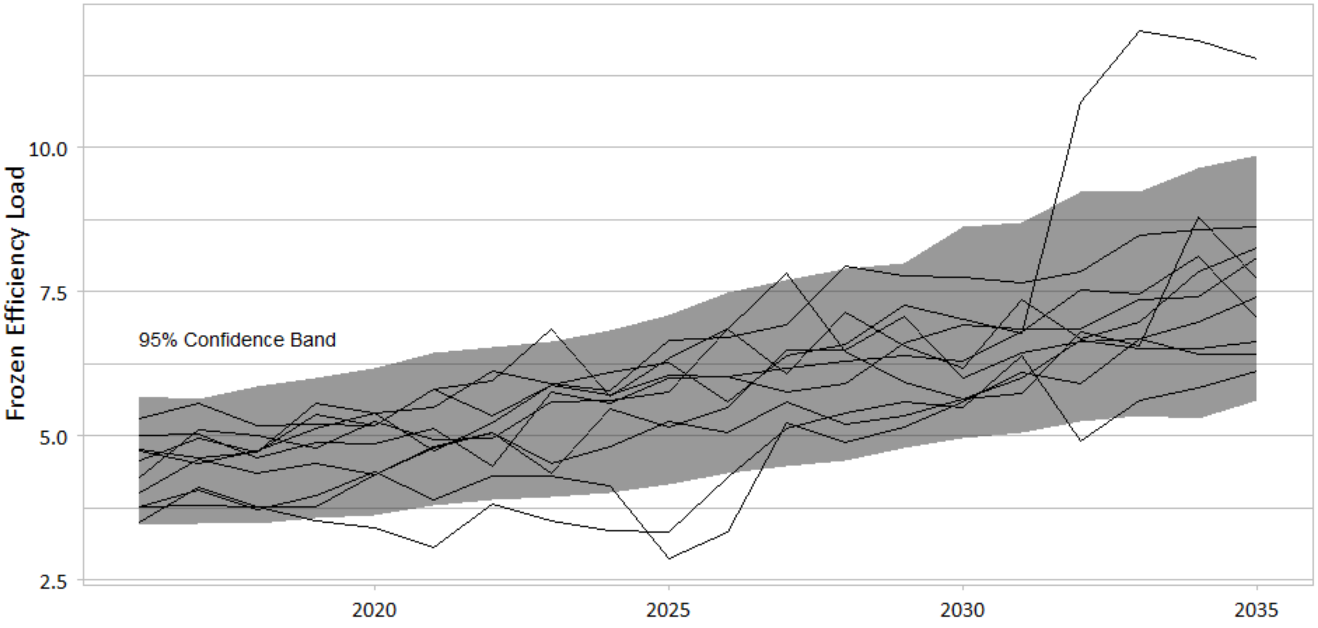
Market-based Prices

There are many market-based prices that have some impact on the cost of the power system. For testing the cost and risk of pursuing different resource strategies the two types of prices that are most critical are the price of the fuel for thermal generators and the price of buying or selling power into the regional or west coast market.

Fuel Prices

Forecasts for the fuel prices for thermal generators including coal, uranium and natural gas are described in Chapter 8. Because natural gas is often the marginal fuel source in the region, the price of natural gas is modeled as varying over the potential futures. Details of how these futures are developed are included in Appendix L. Since coal and uranium are seldom on the margin in setting the price of the market, the forecast for these fuels are held constant over the potential futures.

Figure 15 - 2: Example of forecast potential future natural gas prices



Import and Export Electricity Prices

Being interconnected to other regions helps the Northwest reduce the cost of serving regional load. This is done by either selling electric power to other regions when the Northwest has surplus capability or buying power from other regions when it is less expensive than producing power for generators within the Northwest. The price of buying and selling power outside the region is impacted by the supply and demand dynamics inside the region. In analyzing different resource strategies, both the price for importing and exporting electricity and the interaction with the power system in the Northwest are modeled as varying over the futures. Further the impact of a resource strategy on these futures is estimated. Details of how these prices are developed are covered in Appendix L. The interaction with the resource strategy is discussed further in the section on Testing Resource Strategies later in this chapter.

Figure 15 - 3: Example futures for the prices of importing or exporting electricity

Carbon Emissions Policy

Policies on mitigating carbon dioxide, CO2, emissions can take several different forms. One way of impacting policy is to assign a price to the emission of CO2, whether implicit or explicit. Another method is to examine retirement of resources that emit CO2. In analyzing alternative resource strategies, both of these methods were used. In some scenarios a fixed price was assigned, in some the price was varied over the potential futures and in other scenarios retirements were examined. The various approaches are discussed further in the section on Developing Resource Strategies later in this chapter.

ESTIMATING FUTURE SYSTEM COST

Comparing alternative resource strategies requires measuring differences between these strategies. Perhaps the most important measurement is an estimate of the future system cost to derive the cost of the power system. This requires estimating the carrying cost for the existing power generation system as well as forecasting the new costs associated with any particular resource strategy. The significant costs and benefits that are evaluated in the RPM are the cost of conservation, new generating resources and demand response, resources for renewable portfolio standards (RPS) and operating costs of the existing system.

Conservation

Acquiring conservation has both costs and benefits. To evaluate the value of conservation the supply is aggregated into blocks of sufficient granularity to not obscure comparison to other resources. The measures and aggregation strategy is described in Chapter 12.

The resource strategy assumes that the availability of conservation differs between discretionary and lost opportunity conservation. In the case of discretionary conservation the supply decreases as more is purchase. In the case of lost opportunity conservation, if it is not purchased there is a lag before the next opportunity to purchase the resource opens up. For a more in-depth discussion of how each type of conservation is modeled for estimating the available resource see Appendix L.

The acquisition of conservation is generally assumed to be dynamically altered based on market conditions. The resource strategy increases or decreases this amount uniformly over the study and measures the costs and benefits associated with this strategy.

When a conservation measure is acquired it is assumed the costs cover resource acquisition for the duration of the study. Thus starting the quarter after conservation is acquired the levelized cost of the conservation is included in the system cost.

On the benefit side, conservation reduces the need for regional generation to serve load, both energy and capacity. This translates into a benefit when the regional generation can sell into the external market and make a profit or when purchases from outside the region can be reduced and thus reduce the system costs.

New Generating Resources and Demand Response

The analysis of resource strategies involves selecting options to develop new generating resources and demand response. The option to develop these resources includes a small planning costs but the far more significant cost is when a resource is constructed. Because the longest lead time for a new resource is 30 months, for a combined cycle natural gas plant, it is assumed that once construction is started that it is completed.

The Regional Portfolio Model (RPM) uses two decision rules to determine when a generating resource moves from an option to construction. Resources are built if they are needed to satisfy a regional adequacy requirement or if they are economical, i.e., can recover their full cost by selling into the market. For each resource strategy the RPM forecasts the need for new resources to meet adequacy as well as the potential for profit from constructing an optioned resource. Either one of these evaluations can result in a resource option moving into the construction phase. When that occurs, the cost of constructing the resource is added into the system costs and the dispatch costs are added in after the construction is complete.

The RPM calculates the benefits of new generating resources and demand response by comparing the variable cost of the resource to the price for importing or exporting power. If the cost of the new resource is lower than market prices the cost of importing power is reduced or the revenue from selling the power outside the region is credited to the regional system cost.

Renewable Portfolio Standards

Fulfilling Renewable Portfolio Standards including accounting for the banking of Renewable Energy Credits is part of estimating the system cost. Currently the states of Montana, Oregon and Washington have RPS. In evaluating the system cost the initial assumptions used are given in Table 15 - 1 and the RPS assumptions for these states are given in Table 15 - 2. Finally the estimated fraction of load in each state that is obligated under the RPS is given in Table 15 - 3.

Table 15 - 1: Initial RPS Assumptions

	MT	OR	WA
Current qualifying resources (aMW/ yr)	**105**	**759**	**945**
Credits remaining at beginning of study	**69**	**3747**	**1229**
REC Expiration Time (Years)	**3**	**RECs do not expire**	**2**

Table 15 - 2: RPS Requirement by State

Calendar Year	MT	OR	WA
2015	**15.0%**	**15.0%**	**3.0%**
2016 to 2019	**15.0%**	**15.0%**	**9.0%**
2020 to 2024	**15.0%**	**20.0%**	**13.9%**
2025 to 2035	**15.0%**	**19.8%**	**13.9%**

Table 15 - 3: Fraction of State Load Obligated under RPS

	MT	OR	WA
2015 to 2024	**56%**	**71%**	**76%**
2025 to 2035	**56%**	**100%**	**76%**

All resource strategies are assumed to meet RPS in the most cost-effective manner.

Existing Resource Operating Costs

The operating costs of the system such as fixed O&M (Operations and Maintenance), variable O&M and fuel costs are part of the system cost estimation. The fixed portion of these costs are incurred while the existing resources are still in operation and thus they are included in the model until a plant is assumed to be retired. The variable costs are part of the dispatch of the system and are included in the system costs when an existing resource is dispatched.

For evaluation of these costs the existing natural gas resources are grouped by heat rate. The hydroelectric system is assumed to have a dispatch that varies based on water conditions as described in Chapter 11. Coal resources without an announced retirement date are grouped into a dispatch block and resources that do not dispatch to market prices, also called must-run resources, are grouped into a single block. These blocks are dispatched according to estimated market conditions in economic merit order (i.e., least cost first) when compared to any new resources obtained or dispatched within the same period.

TESTING RESOURCE STRATEGIES

The Regional Portfolio Model

The Regional Portfolio Model (RPM) is the model used to estimate the system costs of a resource strategy under a given scenario. The RPM is described exhaustively in appendix L. The RPM tests a wide range of resource strategies including the amount of conservation developed, the amount of demand response optioned and the amount of thermal and renewable resources optioned. Given the potential futures, the RPM estimates the capital costs for constructing new resources and the dispatch costs of new and existing resources as described in the previous section of this chapter. Each future then results in an estimate of the system costs.

The futures with the lowest expected system costs or the lowest risk, defined as the average system cost of the 80 most expensive futures. Resource strategies that minimize the cost, the risk or both are considered optimal for a scenario. In this case “optimal” is limited to a comparison to the range of strategies tested by the RPM. Because of the complexity of the system cost calculation in RPM, it is impossible to guarantee an optimal result without calculating every possible resource strategy. Modern computers are not yet powerful enough to complete this level of calculation in a reasonable amount of time. Instead some enhanced methods of searching through the resource strategy were used. Further discussion of this is reserved for Appendix L.

Uncertainty in System Costs

Each resource strategy results in a distribution of system costs. This is represented by the 800 specific system cost estimates, one for each of the potential futures described above. For comparison purposes the expected value of the distribution is often used. Another measure of comparison is the TailVar90 or CVar90, which is the expectation of the top 10 percent of the system costs, or the average of the top 80 system cost values.

These distributions represent the fact that future system costs are unknown. Figure 15 – 4 illustrates how a distribution is generally graphed and Figure 15 - 5 gives an example of the system cost distribution from several scenarios detailed later in this chapter.

Figure 15 - 4: How to Interpret distribution graphs

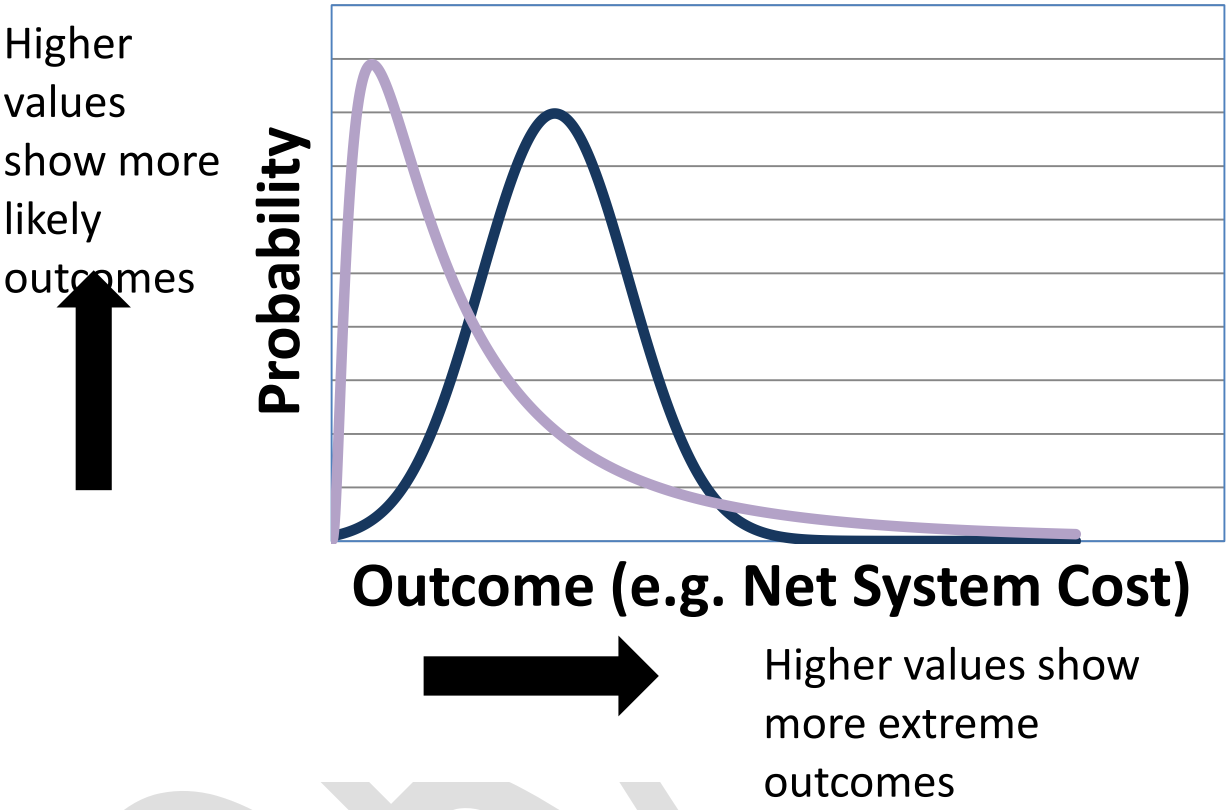
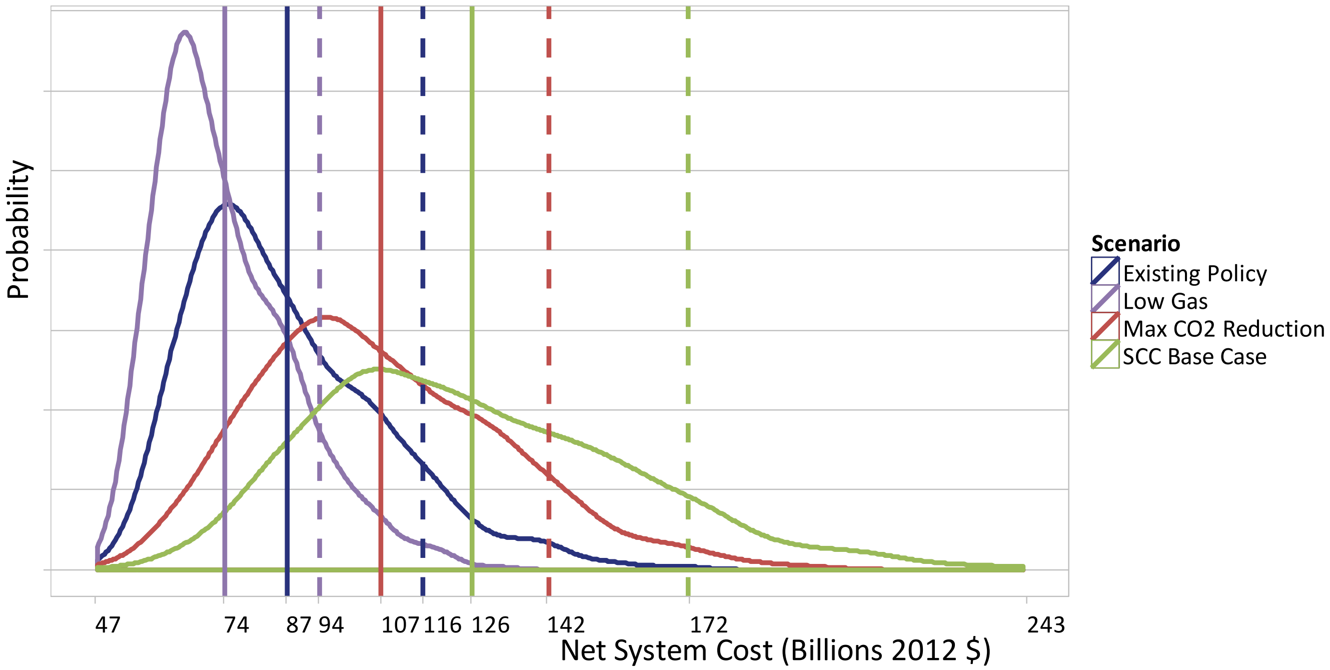


Figure 15 - 5: Distribution of System Costs Example



When testing resource strategies the uncertainty associated with a strategy or scenario is important. Where there is a material impact on the future system cost uncertainty, it is detailed in Chapter 3.

Resource Strategy Adequacy

The system need to meet regional resource adequacy requirements is detailed in Chapter 11. The RPM tests a resource strategy for adequacy. In the event that the strategy does not have sufficient resource to meet adequacy standards a penalty is assessed. Further if the deficiency in resource leads to a load curtailment during the dispatch of resources a further penalty is assessed. For the sake of comparison, when the system costs are reported they do not include the penalty. However, when the RPM looks for an optimal strategy the penalty is part of that calculation. The penalty is set around $6 Million per quarter in real 2012 dollars per Peak MW or aMW if the resource strategy results in capacity or energy inadequacies respectively. This number was selected to make being inadequate more expensive than any of the resource options for a single quarter. The penalty for load curtailment is $10,000 in real 2012 dollars per MWh curtailed. How adequacy is modeled in RPM is discussed further in Appendix L.

DEVELOPING SCENARIOS

Testing the resource strategies over many potential futures helps determine if a resource strategy is cost-effective, including consideration of potential future risks. One concern is assessing these risks is that the estimated range of these risks does not have an appropriate likelihood. While many of the methods have underlying likelihood models, developing scenarios helps test if resource strategies are robust under different conditions or likelihoods. For a more detailed description of the underlying likelihood models or distributional assumptions used in developing the futures see Appendix L. The motivation behind and general description of the scenarios is in Chapter 3. This section will describe how these strategies were developed for the resource strategy analysis.

Existing Policy, No Carbon Risk

In this scenario, the price associated with CO2 was set to zero. This scenario tested resource strategies that have no consideration for CO2 cost or risk. Since new coal plants were not considered, this scenario may not fully capture the implications of a strategy without regard for CO2 emissions. However, it captures a set of futures where current policies are not expanded and coal generation is no longer built.

Social Cost of Carbon, Base Case and High Case

In these scenarios, the price associated with CO2 was set to the social cost of carbon as released by the Interagency Working Group on the Social Cost of Carbon. The annual average prices for both the base case and the high case are given in Table 15 - 4.

Table 15 - 4: Social Cost of Carbon Assumptions (2012$/Metric Ton)

Fiscal Year	Social Cost of Carbon Base	95% Social Cost of Carbon - High
FY16	$40.99	$121.00
FY17	$42.07	$125.00
FY18	$43.15	$129.00
FY19	$45.31	$134.00
FY20	$46.39	$138.00
FY21	$46.39	$141.00
FY22	$47.47	$145.00
FY23	$48.54	$148.00
FY24	$49.62	$151.00
FY25	$50.70	$154.00
FY26	$51.78	$158.00
FY27	$52.86	$161.00
FY28	$53.94	$164.00
FY29	$55.02	$167.00
FY30	$56.10	$172.00
FY31	$56.10	$175.00
FY32	$57.17	$178.00
FY33	$58.25	$181.00
FY34	$59.33	$186.00
FY35	$60.41	$189.00

Carbon Risk

In this scenario, the price associate with CO2 per metric ton was modeled as a regulatory risk. The range of the potential carbon price was fixed between $0 and $110 in real 2012 dollars. The price can be applied starting from the 2015 through 2035. The potential of the price starting to apply within this period makes this more consistent with an explicit price for CO2. This scenario was consistent with the CO2 risk analyzed in the 6th Power Plan and allows some comparison between plans. More details on the CO2 risk model is in Appendix L.

Increased Renewable Portfolio Standards (RPS) to 35%

This scenario involved increasing the RPS to apply to all regional load and moved the RPS to 35%. This was ramped in for both the percentage of load to which it applied and the level of RPS. Table 15 - 5 shows the RPS requirement assumptions by state and Table 15 - 6 shows the percentage of load in each of the four states to which the RPS was applied. Both of these were designed to reach the full RPS by 2027 so the three year average of CO2 emissions in 2030 would reflect the full RPS achievement.

Table 15 - 5: RPS Requirement Scenario Assumptions

Simulation CY	MT	OR	WA	ID
2015	**15%**	**15%**	**3%**	**0%**
2016	**17%**	**17%**	**9%**	**3%**
2017	**18%**	**18%**	**11%**	**6%**
2018	**20%**	**20%**	**14%**	**9%**
2019	**22%**	**22%**	**16%**	**12%**
2020	**23%**	**23%**	**18%**	**15%**
2021	**25%**	**25%**	**21%**	**18%**
2022	**27%**	**27%**	**23%**	**20%**
2023	**28%**	**28%**	**26%**	**23%**
2024	**30%**	**30%**	**28%**	**26%**
2025	**32%**	**32%**	**30%**	**29%**
2026	**33%**	**33%**	**33%**	**32%**
2027 to 2035	**35%**	**35%**	**35%**	**35%**

Table 15 - 6: Percent of Obligated Load Assumptions

Simulation CY	MT	OR	WA	ID
2015	**56%**	**71%**	**76%**	**0%**
2016	**60%**	**73%**	**78%**	**8%**
2017	**63%**	**76%**	**80%**	**17%**
2018	**67%**	**78%**	**82%**	**25%**
2019	**71%**	**81%**	**84%**	**33%**

2020	**74%**	**83%**	**86%**	**42%**
2021	**78%**	**86%**	**88%**	**50%**
2022	**82%**	**88%**	**90%**	**58%**
2023	**85%**	**90%**	**92%**	**67%**
2024	**89%**	**93%**	**94%**	**75%**
2025	**93%**	**95%**	**96%**	**83%**
2026	**96%**	**98%**	**98%**	**92%**
2027 to 2035	**100%**	**100%**	**100%**	**100%**

Maximum Carbon Reduction with Current Technology

This scenario involves retiring all existing coal plants serving regional load by 2026 and retiring all existing natural gas plants serving regional load with heat rates greater than 8500 Btu/kWh by 2031.

Resource Uncertainty

Two scenarios were run to examine the impacts of resource uncertainty. One in which a non-CO2 emitting resources were retired in 2016, 2019, 2022 and 2025 for a combined total of around 1000 MW Nameplate. The other scenario involved a similarly sized non-CO2 emitting resource being randomly shut down or retired sometime between 2016 and 2035. This was done using a uniform probability of retiring for each quarter of the date range.

Faster and Slower Conservation Deployment

These scenarios involved changing the input assumptions for the maximum achievable conservation per year and the ramp rate at which it can be acquired. Chapter 12 discusses the development of the input assumptions for faster and slower ramping of conservation programs. For a more detailed description of how the maximum available conservation per year, the percent of that conservation that can be achieved by program year and the maximum conservation that can be achieved over the 20-year study period see Appendix L.

No Demand Response

For this scenario, the resource strategies were restricted so that they could not select Demand Response as a resource to option. For a description of the optioning logic in the RPM see earlier in this Chapter on estimating the cost of new generating resources and Demand Response.

Low Natural Gas and Wholesale Electricity Prices

This scenario explores the implications of extremely low natural gas prices and the corresponding impacts on other fuel prices and electricity prices. This includes a reduction in coal prices, for example the prices for coal in Montana start around $0.03 less per MMBTU in this scenario and by 2035 are around $0.17 less in real 2012 dollars. The range of natural gas prices is based on re-centering the prices around the low forecast range as described in Chapter 8. The resulting range of natural gas prices can be seen in Figure 15 - 6. The electricity prices used in examining the resource strategies under this scenario are then centered around an electricity price forecast based on this low natural gas price forecast and the resulting range of electricity prices for importing or exporting power generation can be seen in Figure 15 - 7.

Figure 15 - 6: Range of Natural Gas Prices

Figure 15 - 7: Range of Electricity Prices

Increased Reliance on External Markets

In this scenario, the resource base requirements for reliability are relaxed. This was done by reducing the Adequacy Reserve Margin as described in Chapter 11. While the ARM for energy is roughly the same in this scenario at around -3% the ARM for capacity is reduced from around 3% to almost -1%. The result of this is that less resource is required to be built for capacity adequacy.

Lower Conservation, No Carbon Risk

In this scenario, the resource strategy was limited so that conservation could only be purchased if its cost was anticipated to be at or below parity with market prices. These same restrictions were not applied to other resources. This scenario is useful in examining the cost of this conservation purchasing scheme compared to developing conservation as a long-term avoided resource cost.