Key Analysis Components

For this IRP, PSE developed seven scenarios and seven sensitivities to capture a wide spectrum of possible future outcomes.

I. Overview

Planning scenarios and sensitivities are key components of PSE's resource planning process. Using them allows the company to evaluate the costs and risks associated with a multitude of possible futures, resource combinations, and the timing of resource additions. Key inputs to the analysis include demand forecasts (described in Chapter 4), resource alternatives (described in Chapters 5 and 6) and the price forecasts, emissions assumptions, and resource cost forecasts described in Section IV of this chapter.

For the 2009 IRP planning cycle, developing scenarios and sensitivities for long-term planning was particularly challenging. The economic fundamentals that existed when PSE began this planning cycle became outdated, and new patterns have yet to be established. Policy issues with great importance to utility operations remain undecided, such as CO_2 costs and the potential for a federal renewable portfolio standard (RPS). Technology has not yet significantly increased the types of commercially viable renewable resources that are capable of generating utility scale power, and infrastructure limitations still restrict the company's options. Meanwhile, utilities continue to be responsible for reliably and cost-effectively meeting the energy needs of their customers.

Underlying economic conditions shifted dramatically during the two-year planning cycle, so much so that in early 2009 PSE determined it was necessary to develop two additional low-demand scenarios to reflect deteriorating economic conditions and their effect on PSE's load. Altogether, seven scenarios were developed to test the performance of a variety of portfolios in different potential futures.

- 2007 Trends
- Green World
- 2007 Business as Usual (2007 BAU)
- High Growth
- Low Growth
- 2009 Trends
- 2009 Business as Usual (2009 BAU)

In order to test how a single important unknown might affect resource decisions, PSE also tested the following sensitivities.

- Very High Gas Prices

- Very Low Gas Prices
- High Resource Costs
- Low Resource Costs
- High Renewable Portfolio Standards (RPS)
- Low Renewable Portfolio Standards (RPS)
- Transportation Load effects

With one exception, all of the sensitivities were tested in the 2007 Trends reference scenario. The exception — the Very Low Gas Price sensitivity – was tested in the 2007 Business as Usual scenario to investigate the sensitivity of portfolio builds to gas prices absent a CO_2 cost.

Figure 3-1 illustrates the seven planning scenarios and relevant sensitivities.

Figure 3-1
Planning Scenarios

II. Scenarios

Scenarios help us understand how changes in fundamental market conditions affect the cost and risk of various resource plans. Scenarios provide different "pictures" of the future that allow us to incorporate significant changes to important issues that are observed today, but whose outcome is unknown. Scenarios reflect a set of integrated assumptions that could occur together, such as high economic growth that leads to high demand for resources, and ultimately, high resource costs. Lastly, scenarios reflect uncertainty about the performance of the economy, environmental regulation, natural gas prices, and energy policy.

Reference case scenarios provide a starting set of assumptions so that other scenarios can be described by how they differ from that benchmark. People often assume that the reference case created for planning purposes is a reflection of current trends, and in less volatile times this is sometimes true – but not in this instance. The reference case depicted here was developed in late 2007 under very different economic conditions; despite how conditions have changed, its value as a reference case remains. The reference case still makes it possible for PSE to compare meaningful differences between scenarios.

Below, we describe the seven scenarios created for PSE's 2009 IRP electric and gas planning analysis. Five of these were developed at the beginning of the 2-year process in late 2007 and early 2008. Two additional scenarios were created in the spring of 2009 to reflect increasingly pessimistic economic conditions. Subjective probabilities are not assigned to the likelihood of any particular scenario occurring; in other words, it is important to remember that no scenario is judged to be more likely to occur than any other.

When reading the descriptions of scenarios, sensitivities, and key assumptions it is important to note that unless otherwise stated, all dollar amounts are in nominal dollars.

A. 2007 Trends Scenario

The 2007 Trends scenario establishes a starting-point baseline for comparison to the scenarios, so it is described in the greatest detail. Modifications made in the other scenarios and sensitivities are deviations from these reference points.

Resource costs. The estimated cost of generic resources is based on offers received in response to PSE's formal 2008 Requests for Proposals (RFPs), along with information obtained during 2008 as part of PSE's ongoing market activity. Offer prices received were not firm and were occasionally revised upward. The cost of each resource is escalated at varying rates over the 20-year time horizon.

- For gas combined-cycle plants and wind plants, PSE developed cost escalation rates using studies produced by ION Consulting as a starting point.
- For solar capital costs, the company used escalation rates from the "Annual Energy Outlook 2008" published by the Energy Information Administration (EIA).
- For conventional coal and IGCC escalation costs, we relied on the historical relationship between the Producer's Price Index and the cost of resources.
- Biomass and geothermal cost escalation rates were kept constant in real terms; in other words, the nominal cost rises at the same rate as inflation.
- A 2.5% annual inflation rate was assumed in this analysis.

In general, cost assumptions used in this reference case are higher than those used in the 2007 IRP. For the most part, they represent the "all-in" cost to deliver a resource to customers, which includes plant, citing, and financing costs. PSE's activity in the resource acquisition market during the past five years informs the company's cost assumptions, and our extensive discussions with developers, vendors of key project components, and firms that provide engineering, procurement, and construction services lead us to believe the estimates used here are appropriate and reasonable.

Heat rates. PSE applies the improvements in new plant heat rates as estimated by EIA in the 2007 Trends scenario. New equipment heat rates are expected to improve slightly over time, as they have in the past.

Regional demand growth. Demand growth varies by area in the Western Electric Coordinating Council (WECC). These regional demands affect PSE costs because the company competes for resources with other WECC sub-regions.

- For the Northwest states, demand growth is based on the 2006 Northwest Regional Forecast, published by the Pacific Northwest Utilities Coordinating Council (PNUCC).
- For the non-northwest regions, PSE uses estimates provided by the AURORA model developer EPIS.

According to these sources, the annual demand growth in the WECC ranges from 2.5% in the Southwest to 1.4% in the Northwest.

PSE demand growth. PSE-specific demand growth incorporates assumptions about regional demand growth, but also includes many factors specific to its service territory. Development of PSE demand forecasts is discussed in detail in Chapter 4. For this reference scenario, we assume the 2007 Base Case demand forecast.

Natural Gas prices. Gas price forecasts are a combination of forward marks in the near term and Global Insight forecasts for the longer term.

- From 2010 through 2013, PSE used the three month average of forward marks for the period ending July 1, 2008. Forward marks reflect the price of gas being purchased at a given point in time for future delivery.
- Beyond 2013, PSE uses long-run, fundamentals-based gas price forecasts acquired from Global Insight. Global Insight's modeling assumptions and resulting forecasts are first compared with other forecasts for reasonableness.

CO_2 costs. This scenario assumes a CO_2 charge of $37 per ton starting in 2012, increasing to $130 per ton by 2029.

Production tax credits. The Production Tax Credit (PTC) is a federal subsidy identified in the American Recovery and Reinvestment Act of 2009 (ARRA) for production of renewable energy. Currently, the PTC amounts to approximately $21 (in 2010 dollars) per MWh for 10 years of production after a project is placed into service. The PTC is indexed for inflation and is currently scheduled to expire at the end of 2012 for wind resources and 2013 for other qualifying resources. This scenario assumes PTCs are extended at the current rate through 2013, and that no further PTCs are available for new resource development as of 2014.

Investment tax credits. The Investment Tax Credit (ITC) is another federal subsidy related to production of renewable energy. Currently, the ITC amounts to approximately 30% of the capital cost for solar resources and 10% of the capital cost for biomass and geothermal resources; it is scheduled to expire at the end of 2016. Through 2016, this scenario assumes ITCs remain at current levels; beginning in 2017 and for the remainder of the time horizon, they drop to 10% for solar and remain unchanged for biomass and geothermal.

Renewable portfolio standards. Renewable portfolio standards (RPS) currently exist in 29 states and the District of Columbia, including most of the states in the WECC[1] and British Columbia. They affect PSE because they increase competition for development of such resources. Each state and territory defines renewable energy sources differently, sets different timetables for implementation, and establishes different requirements for the percentage of load that must be supplied by renewable resources.

To model these varying laws, PSE first identifies the applicable load for each state in the model and the renewable benchmarks of each state's RPS (e.g. 3% in 2015, then 15% in 2020, etc.). For each state the company then applies those requirements to loads. No retirement of existing WECC renewable resources is assumed, which perhaps underestimates the number of new resources that need to be constructed. After existing and "proposed" renewable energy resources are accounted for, "new" renewable energy resources are matched to the load to meet the applicable RPS. Following an internal and external review for reasonableness, these resources are created in the AURORA database. Technologies included wind, solar, biomass and geothermal. Creation of RPS resources was guided by estimates of potential production by states that appear in the "Renewable Energy Atlas of the West," which can be found at www.EnergyAtlas.org. These vary considerably depending on local conditions; Arizona, for example, has little wind potential but great solar potential. Appendix I, Electric Analysis, includes a table that identifies renewable portfolio standards by jurisdiction.

Build constraints. PSE added constraints on coal technologies to the AURORA model in order to reflect current political and regulatory trends. Specifically, we limited conventional coal to the central states to meet load growth. For certain other states, coal resources were reduced even further due to regulatory constraints or uncertainties. For instance, Washington state law RCW 80.80 (Greenhouse Gases Emissions-Baseload Electric Generation Performance Standard) clearly prohibits construction of new coal-fired generation within the state without carbon capture and sequestration. Absent constraints, the AURORA model would have identified coal as a least cost resource and built a large number of coal units in the WECC – more than seems reasonable given present-day trends and attitudes.

[1] At http://www.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#chart, the U.S. Department of Energy website includes a summary of state RPS requirements with links to more detailed information.

B. Green World Scenario

The Green World scenario investigates the consequences of a future in which, relative to the 2007 Trends reference case,

- CO_2 emission costs are much higher,
- gas prices are much higher,
- demand for electricity is lower because of price and social preference,
- and resource costs are higher.

Demand growth. A low growth rate has been applied for the WECC region, and the 2007 Low Growth demand forecast has been applied for PSE.

Gas prices. Gas prices are expected to move higher as developers of new generating resources move from coal to natural gas to satisfy legal and environmental requirements, thereby increasing natural gas demand. The region's use of gas-fired generation increases as more intermittent renewable energy generation comes online (wind and solar). For Green World, PSE applies Global Insight's long-run high forecast.

CO_2 costs. CO_2 emission costs rise from $55 per ton in 2012 to $150 per ton in 2029 – much higher relative to the reference scenario. Quantitative values were estimated based on the Wood Mackenzie report cited in the Emissions Cost Assumptions section of this chapter.

Production tax credits. PTCs are extended through 2015.

Resource costs. High resource costs exist as more stringent environmental regulations are assumed to drive up the cost of raw inputs, including industrial manufacturing, siting, and construction.

C. 2007 Business as Usual (2007 BAU) Scenario

The 2007 Business as Usual scenario is characterized by

- continued political discussion about important energy policies, but no actions actually being taken;
- emissions costs that are less stringent;
- and fewer constraints on conventional coal plants.

While this scenario may seem unlikely at a time when the state of Washington is moving to enact carbon regulations, consideration of this future is important to understanding risks associated with pursuing resource strategies based on significant carbon costs.

Natural Gas prices. This scenario uses the same natural gas price forecast as the 2007 Trends scenario.

CO_2 costs. $1.60 per ton for 20% of the CO_2 emitted by plants producing greater than 250 MW. This equates to $0.32 per ton, i.e., nearly zero. This cost is based on Washington state law RCW 80.70 – Carbon Dioxide Mitigation.

Production tax credits. PTCs are not extended beyond 2009. (This scenario was developed before ARRA extended PTCs through 2012.)

Build constraints. Conventional coal plants are assumed to be more widely available. Coal remains significantly constrained, primarily to meeting load growth in certain coal producing states. Out-of-state coal plants and the transmission resources they require are considered commercially viable resources for PSE's portfolio analysis in this scenario. This assumption was developed before new revisions to RCW 80.80 were finalized; these appear to foreclose on the option of importing coal-fired generation from out of state.

D. High Growth Scenario

This scenario models more robust long-term economic growth than assumed in the reference case, and is characterized by

- higher demand for energy in the region and in PSE's service territory,
- higher natural gas prices,
- and higher resource costs.

Demand growth*.* High growth rate for demand in the WECC region and, more specifically, the 2007 High demand forecast for PSE.

Natural gas prices. Global Insight's long-run high forecast is applied.

Resource costs. Robust economic growth drives higher demand for generation resources (relative to the reference case), which in turn is assumed to result in high resource costs.

E. Low Growth Scenario

This Low Growth scenario was created before the current economic downturn. This scenario models the impact of weaker long-term economic growth than is assumed in the reference case. This creates

- lower demand for energy in the region and PSE's service territory,
- lower natural gas prices due to lower energy demand,
- and lower cost of energy resources because demand for power plants is depressed by lower economic growth.

Demand growth. A low growth rate has been applied for the WECC region, and the 2007 Low Growth demand forecast has been applied for PSE.

Natural gas prices. Global Insight's long-run low forecast is applied.

Resource costs. Lower resource costs are expected to result from lower demand for energy in this scenario.

F. 2009 Trends Scenario

This scenario was created in early 2009 to reflect altered economic conditions and reflects the following conditions:

- low demand growth,
- low gas prices,
- CO_2 consistent with 2007 Trends,
- and low resource costs.

Demand growth. A low growth rate has been applied for the WECC region, and the 2009 Low Growth Update demand forecast has been applied to PSE's service territory. As explained in Chapter 4, this forecast was updated with the latest macroeconomic data available in February 2009.

Production tax credits. PTC assumptions are based on ARRA, so all PTCs extend through 2012 and only biomass PTCs extend through 2013.

Natural gas prices. To better reflect the gas market as of early 2009, forward marks based on the three-month average for the period ending March 2, 2009 is used for gas prices from 2010 through 2013; thereafter, Global Insight's long-run low forecast applies.

CO_2 costs. The same emissions costs as the reference scenario are used: $37 per ton starting in 2012, increasing to $130 per ton by 2029.

Resource costs. Low resource costs are expected to result from lower demand for energy.

G. 2009 Business As Usual (2009 BAU) Scenario

This scenario is the most pessimistic of the seven. Here, low economic activity leads to

- low demand,
- very low gas prices,
- and no CO_2 legislation is enacted.

Demand growth. This scenario uses the same demand growth as the 2009 Trends scenario.

Natural gas prices. The Very Low Gas Price sensitivity described later in this chapter is used.

CO_2 costs. Negligible CO_2 costs of $0.32 per ton are assumed, the same emissions cost modeled in the 2007 BAU scenario.

Resource costs. Low resource costs are expected to result from lower demand for energy.

Build constraints. Out-of-state coal plants and the transmission resources they require are considered commercially viable resources for PSE's portfolio analysis in this scenario. This assumption was developed before new revisions to RCW 80.80 were finalized; these appear to foreclose on the option of importing coal-fired generation from out of state.

III. Sensitivities

During this planning cycle, a number of discrete variables have grown increasingly difficult to forecast. For this reason, PSE decided to apply sensitivity analysis to examine how changes in a single factor would affect the resource plan. Isolating impacts of specific variables makes it possible to perform an "all else equal" (ceteris paribus) risk analysis. PSE performed sensitivity analyses along with integrated scenario analysis for both the electric and gas portions of this IRP.

A. High and Low Renewable Portfolio Standards Sensitivity

All of the scenarios described above assume meeting current Washington state RPS requirements. PSE wanted to know how changes to that standard might impact resource builds. To test for this sensitivity, the company created high and low variations from RCW 19.285.

- Current targets are 3% of load by 2012, 9% of load by 2016, and 15% by 2020.
- The high RPS sensitivity assumes targets of 4% by 2012, 10% by 2016, 16% by 2020 and 20% by 2025.
- The low RPS sensitivity assumes that the law is changed and only the first level, 3%, is required.

B. High and Low Resource Costs Sensitivity

Resource costs have grown increasingly volatile in the recent past. While PSE's market experience gives us confidence in the resource cost estimates and escalation rates developed for the scenarios described above, PSE wanted to examine this question: Holding all other variables constant, how will changes in resource costs affect plan decisions? Cost escalation rates were developed for all resource alternatives, and then high and low resource cost assumptions were created to test in the 2007 Trends reference scenario.

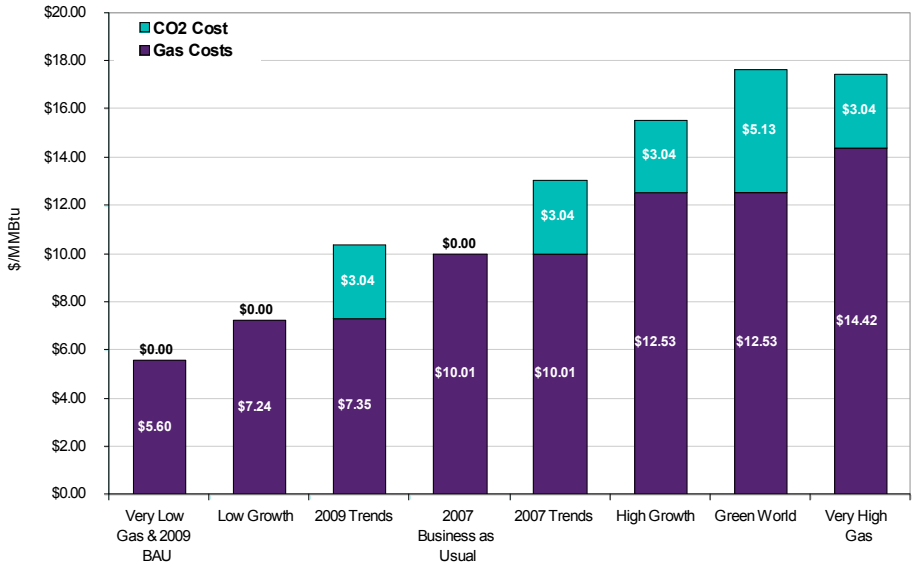
C. High and Low Natural Gas Prices Sensitivity

Market prices for natural gas have been extremely volatile; between July and November 2008, Sumas prices fell from a high of $14.64 per MMBtu to a $6.66 per MMBtu. By April 2009, prices were down to $3 per MMBtu. This price level is outside the ranges depicted in the Global Insight long-run forecasts used in the scenarios. To encompass a broader range of future price possibilities, the company developed very high and very low gas price sensitivities by increasing the Global Insight high prices beyond 2013 and assuming a symmetrical low price. (Unlike the Global Insight forecasts, these are not based on future supply and demand scenarios.)

- The very high gas price sensitivity models a 20-year levelized[2] price of $14.42 per MMBtu, $4.41 higher than the Global Insight price used for the 2007 Trends reference scenario.
- The very low gas price sensitivity models a 20-year levelized price of $5.60 per MMBtu, $4.41 per MMBtu lower than the Global Insight price used in the 2007 Trends reference scenario.

Figure 3-2 shows the full range of levelized gas prices modeled in this IRP, including CO_2 cost (per MMbtu) if applicable to the scenario.

Figure 3-2
Range of Levelized Natural Gas Prices and CO_2 Costs Modeled in the 2009 IRP



[2] Levelized prices are average prices over the 20-year planning period.

D. Transportation Loads Sensitivity

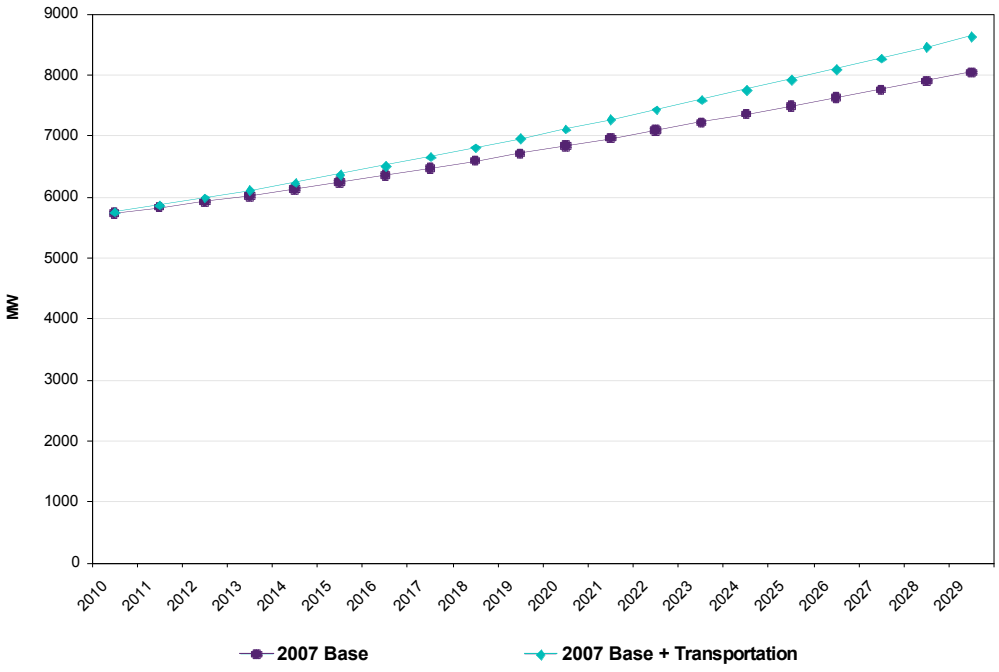
Support at the federal and regional levels for plug-in hybrid electric vehicles (PHEVs) and vehicles powered by compressed natural gas may increase the number of alternative-fuel vehicles operated in PSE's service territory. We wanted to examine the impact that new transportation loads could have on PSE demand forecasts.

To calculate these loads, PSE relied on census data and assumptions in a Northwest Power and Conservation Council study titled "Impact of Plug-in Hybrid Vehicles on Northwest Power System: A Preliminary Assessment." While the study focuses on PHEVs, PSE believes that its assumptions are broad enough to reasonably be used to gauge the discrete additions to both electric and gas loads caused by switching transportation fuels.

Electric transportation load. Figure 3-3 compares the demand curve with and without the transportation load, based on the following assumptions:

- PHEVs will begin to enter the marketplace by 2010 and increase to 20% of the vehicles in the service territory by 2029, or about 500,000 PHEVs.
- The vehicles have a 40-mile, all-electric range.
- The vehicles will charge in the evenings and take eight hours to charge at a rate of 1.25 KW per hour.
- Total demand is discounted to reflect the possibility that not all vehicles may need a full charge or be charging at the same time.

Figure 3-3
Transportation Adds 595 MW to Electric Peak Capacity Resource Need



Gas transportation load. To test how gas demand would be affected, PSE used the same assumptions described above for PHEVs, except that the vehicles' fuel was compressed natural gas rather than electricity. Figure 3-4 shows the incremental increase in gas load needed to meet these requirements.

Figure 3-4

Transportation Adds 56 MDth/Day to Gas Peak Capacity Resource Need

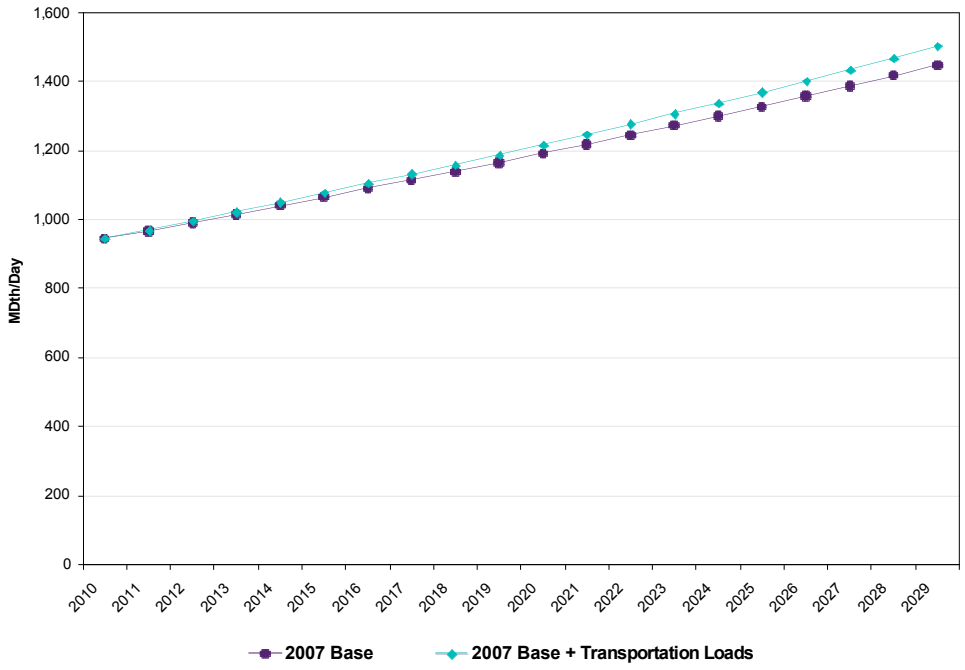


Figure 3-5 summarizes all scenarios and sensitivities used in the analysis.

Figure 3-5
Scenarios and Sensitivities

		Reference Assumptions	Planning Scenarios							Sensitivites					
			2007 Trends	Green World	Low Growth	High Growth	2007 Business As Usual	2009 Trends	2009 Business As Usual	Very High Gas	Very Low Gas	Resource Costs	High RPS	Low RPS	Transport
Theme			Best estimate of current resource costs and characteristics, fuel prices, state laws and moderate federal environmental policies	Support for stronger environmental legislation at the federal level, with continuation of state level RPS	Lower regional and PSE demand load growth based on lower long-term economic growth.	Higher regional and PSE demand load growth based on related long-term economic growth.	Best estimate of current costs with current environmental policies	Lower regional and PSE demand load growth based on lower long-term economic growth.	Lower regional and PSE demand load growth based on lower long-term economic growth.	Impact of very high gas prices	Impact of Very Low Gas Prices	Impact of resource costs greater or lower than reference	Higher RPS than I-937	Lower RPS than I-937	Impact of plug-in electric hybrid vehicles (PHEV) loads
WECC Demand (AURORA)		EPIS Averages: CA: 1.97% SW: 2.5% PNW: 1.43% RM: 1.86%	Reference	Low Growth	Low Growth	High Growth	Reference	Low Growth	Low Growth	Reference	Reference	Reference	Reference	Reference	Reference
PSE Demand		Base: 2%	Base	Low	Low	High	Base	Updated Low	Updated Low	Base	Base	Base	Base	Base	Base + Transport load
Gas Price		Forward marks for 2010-2013, and Global Insights long-run fundamental forecast	Reference	Global Insights long-run high forecast	Global Insights long-run low forecast	Global Insights long-run high forecast	Reference	Global Insights long-run low forecast, with updated forward marks	Very Low Gas price forecast $5.60/MMBtu	Very High Gas price forecasts $14.42/MMBtu	Very low Gas price forecast $5.60/MMBtu	Reference	Reference	Reference	Reference
Coal Price		Global Insight	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Generic Resource Cost ($/KW)		PSE market based estimates	Reference	High Resource Costs	Low Resource Costs	High Resource Costs	Reference	Low Resource Costs	Low Resource Costs	Reference	Reference	High or Low Resource Costs	Reference	Reference	Reference
Emissions (Nominal $/Ton)	CO2		Lieberman-Warner Bill (EPA) Start in 2012 2012: $37 2020: $67 2029: $130	Wood Mackenzie Start in 2012 2012: $55 2020: $129 2029: $150	RCW 80.70 - Carbon Mitigation Plan 250 MW or greater $1.60/ton for 20% of total CO2	Lieberman-Warner Bill (EPA) Start in 2012 2012: $37 2020: $67 2029: $130	RCW 80.70 - Carbon Mitigation Plan 250 MW or greater $1.60/ton for 20% of total CO2	Lieberman-Warner Bill (EPA) Start in 2012 2012: $37 2020: $67 2029: $130	2007 Business As Usual	2007 Trends	2007 Business As Usual	2007 Trends	2007 Trends	2007 Trends	2007 Trends
	SO2	Wood Mackenzie 2010: $229 2020: $1390 2029: $3796	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Nox	Wood Mackenzie 2010: $2413 2020: $1865 2029: $2486	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Production Tax Credits ($/MWh)		$21:2010-2013 For all eligible technologies	Reference	$21:2010-2015 For all eligible technologies	Reference	Reference	none	2012	2012	Reference	none	Reference	Reference	Reference	Reference
Investment Tax Credit		Solar: 30% 2010-2016, then 10% Geothermal and Biomass: 10%	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
RPS		Meet Current State RPS through 2029	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Higher RPS Targets	RPS capped at 3%	Reference
Build Constraints		Limited amount of coal and IGCC builds to meet load growth only. No new nuclear builds.	Reference	Reference	Reference	Reference	Higher amount of coal and IGCC builds allowed (AURORA). Changes to RCW 80.80	Reference	Reference	Reference	2007 Business As Usual	Reference	Reference	Reference	Reference
Renewable Energy Credit ($/MWh)		2010: $8.00 Increase at same rate as wind capital cost: 2011-2029	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

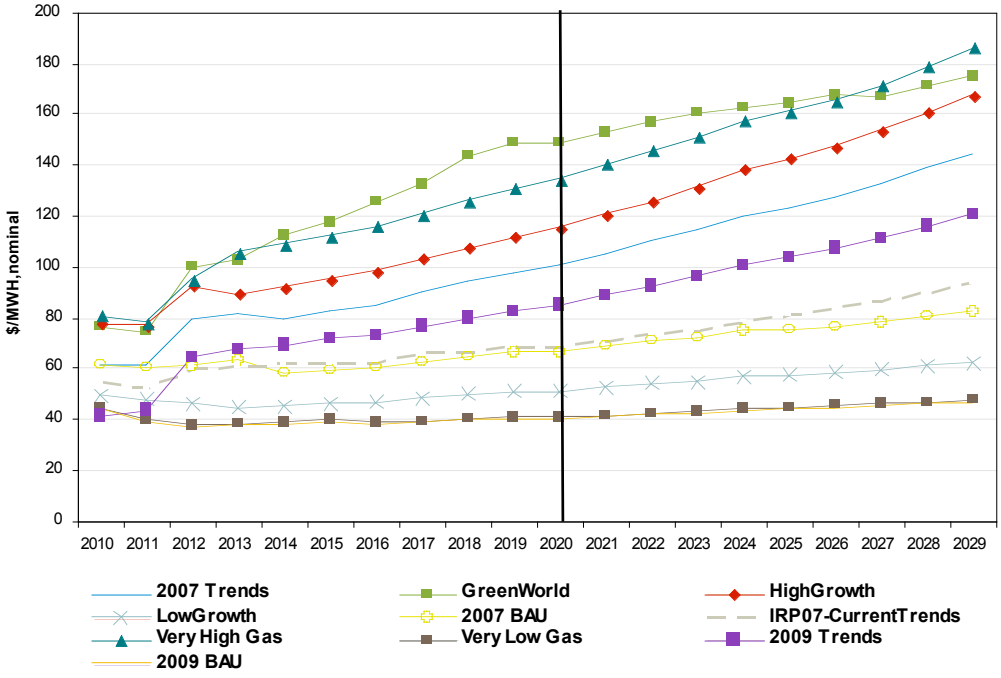
III. Key Assumptions

A. Price Forecasts

Electric price forecasts. Electric market price forecasts for each of the seven scenarios and for the Very High and Very Low Gas Price sensitivities were created using the AURORA model. AURORA calculates these forecasts based on economic, marketplace, and demand assumptions that are specific to each scenario and sensitivity.

The market price forecasts shown in Figure 3-6 below[3] congregate tightly around two key input assumptions: CO_2 costs and natural gas prices. Throughout the analysis, these two factors have the largest influence on overall electric portfolio costs, a reflection of the high proportion of generation that is fueled by natural gas.

Figure 3-6
Comparison of Market Power Price Forecasts

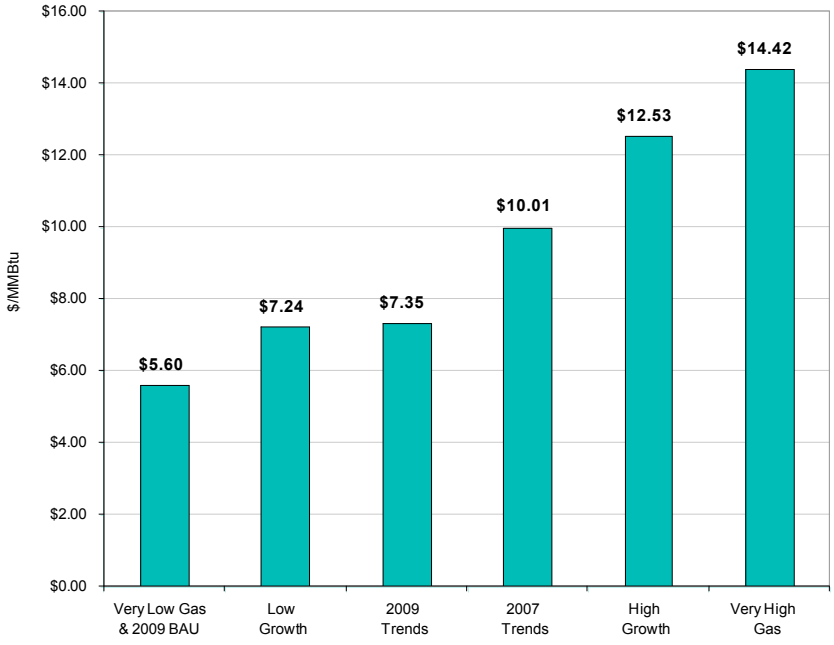


[3] Tables showing the monthly prices for all of the forecasted scenarios appear in the Appendix I, Electric Analysis.

Scenario	Levelized price per MWh	Levelized Gas $/MMBtu	CO_2 cost per ton
Green World	$124	$12.53	$55 to $150
Very High Gas	$120	$14.42	$37 to $130
High Growth	$106	$12.53	$37 to $130
2007 Trends	$91	$10.01	$37 to $130
2009 Trends	$75	$7.35	$37 to $130
2007 BAU	$65	$10.01	$0.32
Low Growth	$50	$7.24	$0.32
Very Low Gas/ 2009 BAU	$41	$5.60	$0.32

Natural gas price forecasts. Gas price assumptions were a combination of forward market prices, followed by fundamental forecasts acquired from Global Insight, a well known macroeconomic and energy forecasting consultancy. Global Insight performs a comprehensive gas market analysis that includes regional, North American, and international factors (including Canadian markets and LNG imports). Figure 3-7, below, illustrates the range of 20-year levelized gas prices used in the analysis.

Figure 3-7
Gas Price Forecasts
(20-Year Levelized Sumas Prices – nominal $)



B. CO_2 Cost Assumptions

Emissions costs, other than the capital and operating costs of certain pollution control equipment, are not a significant energy price factor today; however, in the near future, at least by 2012, we expect new regulations regarding greenhouse gases (CO_2 for modeling purposes). At this time, the people with whom PSE works to track legislative and regulatory issues believe that a regional or national cap and trade system is a reasonable measure and proxy for assumptions concerning future green house gas regulation. To capture a range of uncertainty around CO_2, PSE used a range of estimates as inputs.

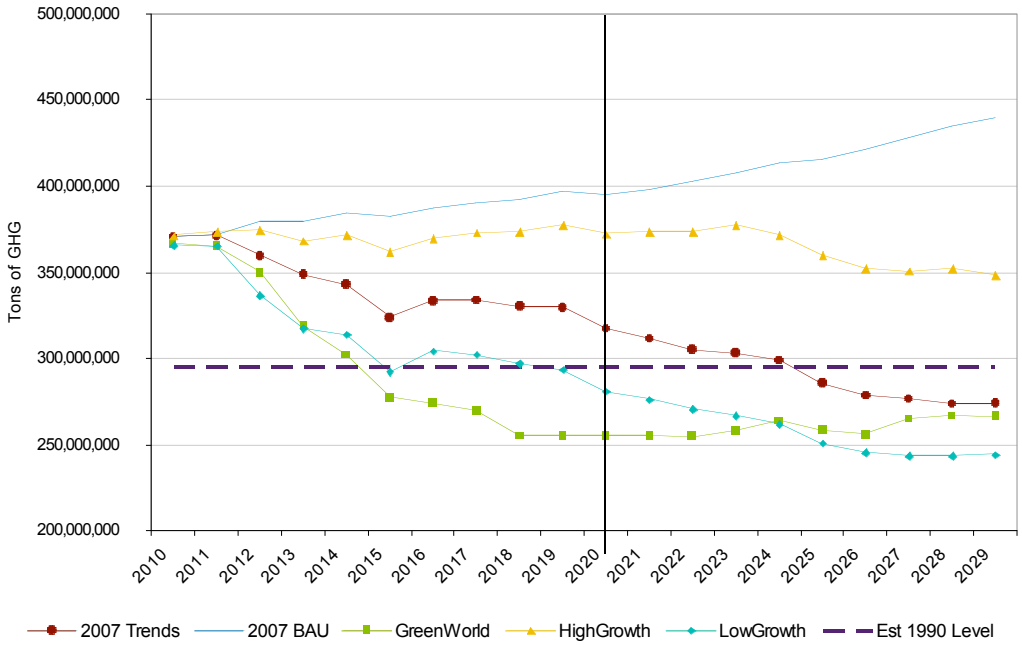
Low CO_2 cost. These assumptions were based on existing Washington law RCW 80.70. This law applies to new fossil fuel fired thermal generation built within the state. For modeling purposes, a reasonable simplification is that compliance requires payment of $1.60 per ton of CO_2 to cover 20% of emissions, or $0.32 per ton. We apply this $0.32 per ton to CO_2 emissions for the entire WECC. Low CO_2 cost was modeled in the Low Growth, 2007 BAU, and 2009 BAU scenarios.

Moderate CO_2 cost. This assumed a cap and trade regulatory scheme and used the CO_2 prices from the ADAGE model published by the Environmental Protection Agency. These prices were then used to develop estimated prices that ranged from $37 per ton in 2012 to $130 per ton in 2029. In this environment, CO_2 costs are reflected in gas prices and power prices. Moderate CO_2 cost was included in 2007 Trends, 2009 Trends, and High Growth scenarios.

High CO_2 cost. This was modeled using a cap and trade regulatory scheme and Wood Mackenzie's "Carbon Casebook 2." These prices were used to develop estimated prices that ranged from $55 per ton in 2012 to $150 per ton in 2029. In this regulatory environment, CO_2 costs are reflected in gas prices and power prices. High CO_2 cost was modeled in Green World.

To find out when (and whether) these CO_2 prices would change dispatch choices enough to reduce emissions in the WECC below 1990 levels, PSE applied the different scenarios across the entire region and used AURORA to calculate the resulting emissions. In Figure 3-8, below, the dashed horizontal line represents an estimate of 1990 emission levels. Here, Green World and Low Growth reach 1990 levels before 2020; 2007 Trends reaches 1990 levels after 2024; and High Growth and 2007 BAU do not reach the target at all.

Figure 3-8
WECC CO_2 Emissions



C. Resource Cost Forecasts

PSE develops forecasts for several resource costs because the differing future economic conditions depicted by scenarios and sensitivities have different implications for resource costs. Included are forecasts for natural gas spot markets, electric spot markets, costs of different kinds of power plants and transmission, and costs of different natural gas transportation and storage alternatives. Table 3-9 below summarizes the supply-side resource costs used in the analysis.

Table 3-9
Resource Cost Assumptions

Generic Resource Costs (2008$)	Units	CCCT	CCCT w CCS	Peaker	Coal SCPC	IGCC	IGCC w CCS	Wind	Long Haul Wind	Solar CST	Biomass	Geothermal
Capacity	*MW*	275	250	160	250	250	250	100	100	50	20	25
Capital Cost	*$/KW*	$1,257	$2,470	$1,240	$4,079	$4,527	$5,960	$2,433	$3,753	$4,950	$2,704	$3,449
O &M - Fixed	*$/kW-yr*	$22.00	$35.07	$23.92	$48.52	$68.14	$80.19	$40.00	$40.00	$63.00	$80.00	$132.00
O &M - Variable	*$/MWh*	$3.00	$4.27	$1.40	$6.67	$4.24	$6.45	$2.00	$2.00	$0.00	$3.00	$1.80
Availability	*%*	95%	95%	98%	90%	85%	85%	30%	36%	28%	85%	95%
Capacity Credit	*%*	93%	93%	93%	93%	93%	93%	5%	5%	5%	93%	93%
Heat Rate - GT	*BtukWh*	7,038	8,424	8,600	8,998	8,573	10,544				14,000	
Heat Rate - Duct Firing	*BtukWh*	8,800										
Fuel Price	*$/MMBtu*	N/A	N/A	N/A							$5.75	
Fixed Gas Transportation	*$/Dth per day*	$0.50	$0.50	$0.18								
Fixed Gas Transportation (Conversion)	*$/kW-yr*	$30.83	$36.90	$4.52								
Fuel Basis Differential	*$/MWh*	$4.32	$5.18	$5.28								
Electric Transmission - Fixed	*$/kW-yr*	$3.63	$3.63	$3.63	$86.48	$86.48	$86.48	$56.80	$125.23	$20.94	$3.63	$23.12
Electric Transmission - Variable	*$/MWh*	$0.00	$0.00	$0.00	$4.53	$4.53	$4.53	$8.32	$16.96	$2.02	$0.00	$2.23
Emissions:												
CO2	*lbs/MMBtu*	117	0	117	212.67	212.67	0					
SO2	*lbs/MMBtu*	0.01	0.01	0.01	0.07	0.07	0.06					
NOX	*lbs/MMBtu*	0	0	0	0.12	0.03	0.03					
Hg	*lbs/MMBtu*											
Location		*PSE Control*	*PSE Control*	*PSE Control*	*MT/WY/ Alberta*	*MT/WY/ Alberta*	*MT/WY/ Alberta*	*WA/OR*	*MT/WY/ Alberta/BC*	*SE OR*	*PSE Control*	*OR/ID*
First year Available		*2010*	*2025*	*2012*	*2018*	*2020*	*2025*	*2010*	*2018*	*2014*	*2012*	*2018*
Notes								*1 BPA Wheel + Integration*		*Includes 5 hours Storage*		