Key Analysis Components

Planning scenarios, portfolios, and price forecasts are key components of PSE's resource planning process. Using them allows us to evaluate the costs and risks associated with a multitude of possible futures, resource combinations, and the timing of resource additions. This chapter is organized in three sections.

I. Overview

A. Scenarios

Scenarios are different “pictures” of the future that allow us to incorporate fundamental changes for important issues that are observed today, but whose outcome is unknown. They depict different potential price-paths for different key variables that may occur as events unfold. These include uncertainty about energy policy, environmental issues, natural gas prices, and the performance of the national and regional economies. Changes in these factors affect the costs and risks associated with using different resources, and therefore inform the choices we make. The six electric and four natural gas scenarios PSE used in this analysis are described in this chapter.

B. Portfolios

A portfolio is a specified set of resources intended to meet the energy and operational requirements necessary to meet customer demands. Designing portfolios that contain different combinations of resources—and then modeling them within the context of each of the scenarios—provides us with insight into specific planning questions and the sensitivities and impacts of a wide range of decisions. PSE designed the electric portfolios in this IRP to provide insight into the effect of different levels of renewable energy in the portfolio, the cost and risk of different fuel choices, and the sensitivity of the timing of these key decisions. PSE’s electric analysis began with the 12 portfolios described in this chapter. Portfolios are not needed in the gas analysis, because we have an optimization model that mathematically solves for the lowest cost portfolio.

C. Price Forecasts

The individual electric and gas scenarios developed depict differing future economic conditions and regional power profiles. These conditions have different implications for resource costs, so price forecasts are developed for each of the scenarios. The appropriate price forecasts are then applied to each portfolio and evaluated for each scenario. Key assumptions included in the development of the price forecasts used are explained in the electric and gas sections of this chapter.

II. Electric Analysis Components

A. Electric Scenarios

PSE created six scenarios for our electric analysis to model a wide range of possible futures. These scenarios represent different potential price paths that may develop over the 20-year planning horizon. Figure 3-1, below, provides a high-level summary of the scenarios, followed by a more detailed explanation.

Figure 3-1
Electric Scenarios

Current Trends
Moderate Gas Prices
Low Carbon Costs
Moderate Load Growth

Green World
High Gas Prices
High Carbon Costs
Moderate- Load Growth

Low Growth
Low Gas Prices
Low Carbon Costs
Low Load Growth

Robust Growth
High Gas Prices
Low Carbon Costs
High Load Growth

Escalating Costs
Current Trends +
Increasing Capital Costs

Technology Improvement
Current Trends +
Declining Capital Costs
Heat Rate Efficiency Improvement

Current Trends

Current Trends represents PSE's reference case scenario. The input assumptions in this scenario include factors that can be observed today and seem likely to continue into the future. Because the reference case is used as a baseline for modifications made in the rest of the scenarios, it will be described in the greatest detail.

Resource costs. The estimated cost of generic resources is based on bids received in response to our formal 2005 Request for Proposals (RFP), along with information obtained during 2006 as part of the Company's ongoing market activity. Bid prices received were not firm and were occasionally revised upward. For long-term modeling purposes, the cost of resources is 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). It is impossible to predict prices with certainty, but some forecasters, such as the U.S. Energy Information Agency (EIA), predict real resource costs will fall over time. Our recent market experience suggests costs are continuing to rise in nominal and real terms.

In general, the cost assumptions used in this reference case are higher than those used in the 2005 Least Cost Plan, and generally represent the "all-in" cost to deliver a resource to our customers. Such cost estimates are higher than cost estimates available from public sources, such as the EIA, which do not reflect "all-in" cost elements. Our real market data reflects our activity in the resource acquisition market during the past five years, and we apply that experience here. 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*.* New equipment heat rates are expected to improve slightly over time, as they have in the past. PSE applies the improvements estimated by EIA to known current heat rates in the Current Trends scenario.

Regional demand growth. Demand growth varies by area in the Western Electric Coordinating Council (WECC). These regional demands affect PSE costs because we compete for resources from related pools. PSE uses estimates provided by the AURORA model developer EPIS, which are based on information from the Northwest Power and Conservation Council (NPCC) and the EIA. Annual demand growth in the region ranges from 2.5% in the southwest to 1% in the northwest according to these sources.

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

Gas prices. Gas price forecasts are acquired from Global Insight, a respected worldwide economic consulting firm, which performs long-run fundamentals-based gas price forecasts. We review the assumptions that go into Global Insight's model and compare their resulting forecast with other forecasts for reasonableness. For the near term (five years), PSE uses forward marks that are currently available in the market. The forward marks reflect the price of gas being purchased today for future delivery. PSE uses forward marks for gas prices for the years 2008 through 2011, and thereafter applies Global Insight's long run reference forecast.

Emissions costs*.* 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 2009, we expect the federal government will institute new regulations regarding green house gases (CO_2 for modeling purposes.) At this time, the people with whom we work to track legislative and regulatory issues believe that the Bingaman-Domenici bill, based on the National Commission on Energy Policy[1], is a reasonable measure and a good proxy to use for assumptions concerning future green house gas regulation. The Current Trends scenario assumes a CO_2 charge of $7 per ton starting in 2012, and that the charge increases 5% per year thereafter (compared to inflation of 2.5% per year). The charge is assumed to apply to both new and existing resources. Charges for multi-pollutants are based on estimates provided by the Environmental Protection Agency[2] (EPA), and assume the Administration's "Clear Skies" initiative is enacted. Clear Skies is very similar to current EPA initiatives. Mercury regulation is not modeled directly as there is uncertainty about potential rules and costs; however, our analysis incorporates the cost of controlling mercury as part of the fixed cost for any new coal burning plants.

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[1] "Ending The Energy Stalemate – A Bipartisan Strategy to Meet America's Energy Challenges"; The National Commission on Energy Policy; December 2004.

[2] "Multi-Pollutant Analysis: Comparison Briefing"; U.S. Environmental Protection Agency; Office of Air and Radiation; October 2005.

Production tax credits. The Production Tax Credit (PTC) is one of many federal subsidies related to production of nuclear, oil, gas and alternative energy. The present PTC amounts to approximately $17 per MWh for ten years of production, and is indexed for inflation. Currently the PTC is scheduled to expire at the end of 2008. We expect it to be extended at least once to 2009, after which there is much uncertainty. This scenario assumes PTCs remain at the current rate through 2009, and drop to a $10 credit in 2010 and 2011, representing a 50% probability that the PTCs will be extended for another two years. PTCs are still assumed to be given to a project for 10 years after it is placed into service. As of 2012, this scenario assumes no further PTCs are available to new resource development.

Renewable portfolio standards. Renewable portfolio standards (RPSs) exist in 23 states and the District of Columbia, including most of the states in the WECC[3]. Each state defines renewable energy sources differently, has different timetables for implementation, and has different requirements for the percentage of load that must be supplied by renewables. To model these varying laws, we first identified the load forecast for each state in the model. Then we identified the benchmarks of each RPS (e.g. 3% in 2015, then 5% in 2020) and applied them to the load forecast for that state. No retirement of existing WECC renewable resources was provided for, which perhaps underestimates the number of new resources that need to be constructed. After existing and expected renewable energy resources were accounted for, new renewable energy resources were matched to the load to meet the RPS. With internal and external review for reasonableness, these resources are created in the AURORA database. The renewable energy technologies included wind, solar, biomass and geothermal. Estimates of potential production by states in the “Renewable Energy Atlas of the West” served to guide the creation of RPS resources. These vary considerably. For example, Arizona has little wind potential but great solar potential. For modeling purposes, some resources for Oregon and Washington are mixed because the area borders do not correspond to the political borders. Since Oregon is considering an RPS, PSE has applied the Washington RPS to both states.

Build constraints. The AURORA model, like all optimizing models, identifies the least cost resource and creates a large number of those units in the WECC on an economic basis. Often, as with coal, the unrestricted level is much greater than seems reasonable

[3] DOE website includes a summary of U.S. RPS requirements with links to more detailed information at

http://www.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#chart given current political and regulatory realities. Hence, we added constraints on coal technologies to reflect present-day trends and attitudes. Specific constraints include limiting conventional coal to the central states and only to meet each state's own load growth. Starting in 2014, the only coal technology assumed to be available in the WECC is IGCC that is carbon sequestration ready, but without actual carbon sequestration installed and operating.

Green World

The Green World scenario enables us to investigate the consequences of a future in which there are much higher emission costs, higher natural gas prices, and a corresponding lower demand for electricity because of price and social preference. The load growth rates for all areas in the WECC are reduced based on the low growth case for PSE's demand.

Gas prices. In the Green World scenario, gas prices are expected to be higher as developers of new generation resources move from coal to gas to satisfy legal requirements, driving up the demand, and thus the price of natural gas. The region will also see increased use of gas-fired generation as more intermittent renewable energy generation comes online (primarily wind and solar). The gas price forecast used is Global Insight's long run high forecast. Forward marks are used for the 2008-2009 period.

Emissions costs. Emission charges for CO_2 are much higher in the Green World scenario, rising from $7 per ton in 2012 for the Current Trends scenario to $24 per ton in 2012 for Green World. Quantitative values for the charges were estimated based on the Environmental Protection Agency report cited above. The specific case is legislation named "The Clean Power Act" which was introduced by Sen. Jeffords. Multi-pollutants costs are based on legislation introduced by Sen. Carper called the "Clean Air Planning Act."

Robust Growth

This scenario models the impact of more robust long-term economic growth than assumed in the reference case, which creates higher demand for energy in the region and in PSE's service territory.

***Demand growth**.* Assumptions for the Robust Growth scenario include a high growth rate for demand in the WECC region and, more specifically, a 2% growth rate for PSE.

Natural gas prices. Gas prices reflect forward marks for years 2008 and 2009; Global Insight's long run high gas forecast has been applied to the remainder of the planning period. Robust growth assumes a higher gas price forecast than Current Trends, but the same emission costs, thus the all in cost of natural gas resources are relatively higher in Robust Growth than in Green World, which has the same gas price forecast but also the higher emission costs.

Low Growth

This scenario models the impact of weaker long-term economic growth than assumed in the reference case, which creates lower demand for energy in the region and PSE's service area.

***Demand Growth*.** A low growth rate has been applied for the WECC region and a 1.3% growth rate has been applied for PSE.

Natural gas prices. In keeping with the lower level of demand, PSE assumes forward marks for gas prices for the years 2008 through 2009, and thereafter applies Global Insight's long run low forecast.

Technology Improvement

This scenario models a future in which technological advances have resulted in improvements to both the heat rate efficiency and the real capital cost of most generating resources. The magnitude of the improvements was identified using the EIA's *Annual Energy Outlook 2006*[4].

***Resource costs and heat rates**.* Initial assumptions about costs and heat rates in this scenario are much more optimistic than what PSE is currently experiencing in the market for new resources. The improvements estimated by EIA were converted to percent changes and applied to PSE's resources to arrive at a corresponding 20-year forecast.

[4] "Assumptions to the Annual Energy Outlook 2006," Energy Information Agency; Report #: DOE/EIA-0554(2006); March 2006.

Another cost difference modeled in this scenario involves the simple cycle gas turbines used as peakers. Historically, the construction cost of a simple-cycle combustion turbine has been lower than the capital cost of a combined-cycle turbine; however, the heat rate for the simple cycle turbine is much higher. There is an economic trade-off between a more expensive, but more efficient, combined-cycle plant that would be used more often, versus a less expensive high-heat-rate turbine that would be used for peaking. The Current Trends scenario does not show this historic differential because current market data indicates such historical cost differentials have narrowed significantly. Greater historic pricing differentials are assumed in the Technology Improvement scenario.

Build constraints. For the AURORA modeling of the Technology Improvement scenario, the cost of new coal plants reflects IGCC with carbon capture and sequestration (CCS) in 2021.

Escalating Costs

In our Technology Improvement scenario, technology advancements drive down real resource costs in the future, ”all else” equal. But what if “all else” is not equal? What if costs continue to increase? The Escalating Cost scenario is a counterpoint to the optimistic Technology Improvement scenario. To develop technology cost input assumptions for this scenario, we relied again on EIA information, though indirectly.

***Resource costs**.* EIA’s base case has a slight decrease in real costs over time. We applied the inverse of the magnitude of the base case change in costs to PSE’s starting costs to create a scenario with escalating costs. Overall, the impact is relatively small, at about a 5% real capital cost increase over 20 years.

Figure 3-2
Six Electric Analysis Scenarios

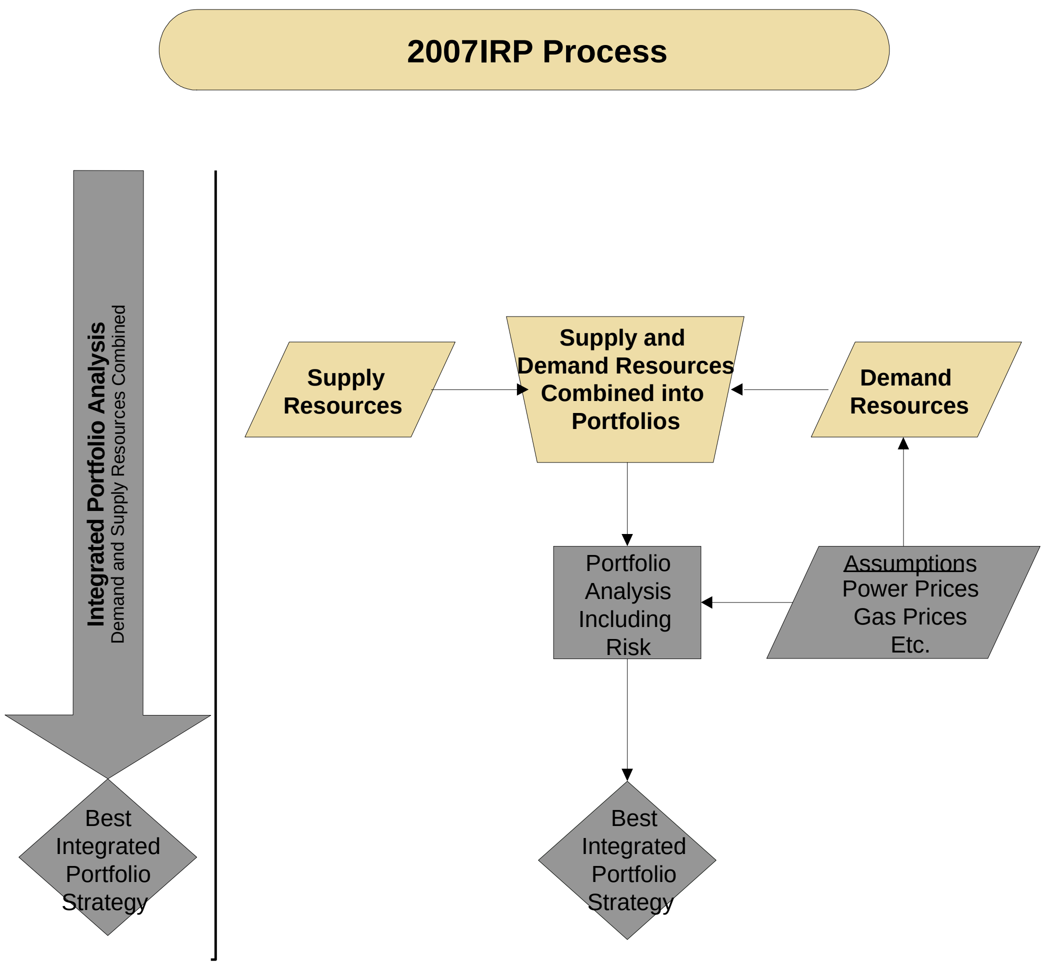
	Current Trends (Reference)	Green World	Low Growth	Robust Growth	Technology Improvement	Escalating Costs
Theme	Best estimate of current resource costs and characteristics, fuel prices, state laws and moderate federal environmental policies	Support for stronger environmental legislation at the federal 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 higher long-term economic growth.	Optimistic outlook regarding technology development and deployment, as well as learning for thermal resources, based on EIA scenario.	Pessimistic view of technology development and deployment with increased costs and reduced availability.
WECC Demand (AURORA)	EPIS Averages CA: 1.97% SW: 2.5% PNW: 1% RM: 2%	Low Growth	Low Growth	High Growth	Reference	Reference
PSE Demand	Base 1.9%	Low 1.7%	Low 1.7%	High 2.2%	Reference	Reference
Gas Price	Forward marks for 2008-2011, and Global Insights long run fundamental forecast.	Forward marks for 2008-2009, and Global Insights long run high forecast.	Forward marks for 2008-2011, and Global Insights long run low forecast.	Forward marks for 2008-2009, and Global Insights long run high forecast.	Reference	Reference
Coal Price	Global Insights	Reference	Reference	Reference	Reference	Reference
Generic Resource Cost $/KW	PSE market based estimates with constant real costs for 20 years	Reference	Reference	Reference	Reference values adjusted per EIA Annual Energy Outlook 2006 (AEO2006) -0.25%/yr Mature -1.25%/yr New	PSE market based estimates with increasing real costs
Generic Resource Heat Rates	PSE Generic Heat Rates with EIA AEO2006 Reference case improvements	Reference	Reference	Reference	Adjustments per AEO2006 Advanced Technology side case	Reference

	Current Trends (Reference Case)	Green World	Low Growth	Robust Growth	Technology Improvement	Escalating Costs
Emissions CO2 (Nominal $/Ton)	"NCEP" (Bingaman) Start in 2012 with 5% annual nominal increase. 2012: $7.00 2020: $10.34 2027: $14.55	"Clean Power" (Jeffords) Start in 2012. Increasing per EPA (10/05) 2012: $ 24.81 2020: $45.35 2027: $70.68	Reference	Reference	Reference	Reference
Emissions SO2 (Nominal $/Ton)	Clear Skies (Bush) Start in 2010 2010: $978 2020: $2105 2027: $3306	"Clean Air Planning Act" (Carper) 2010: $1481 2020:$3191 2027: $5009	Reference	Reference	Reference	Reference
Emissions NOx (Nominal $/Ton)	Clear Skies Start in 2010 2010: $ 297 2020: $640 2027: $1006	"Clean Air Planning Act" (Carper) 2010: $5742 2020: $1522 2027: $1809	Reference	Reference	Reference	Reference
Production Tax Credits ($/MWH)	$19: 2008-2009 $10: 2010 - 2011 For all eligible technologies	Reference	Reference	Reference	Reference	Reference
RPS	Meet current state RPS through 2027. WA & OR meet RPS standards based on WA I-937	Reference	Reference	Reference	Reference	Reference
Build Constraints	**2012-2027:** IGCC + CCS ready Build to meet load growth only. 1 IGCC w CCS in CA.	Reference	Reference	Reference	**2012-2027:** IGCC + CCS ready Build to meet load growth only. **2021-2027:** IGCC with CCS	Reference

B. Electric Portfolios

Hypothetical portfolios used in this resource planning analysis were tested in the different planning scenarios detailed above. PSE performed an integrated analysis, meaning demand-side and supply side resources were combined and analyzed as one integrated portfolio. Portfolios were developed to ensure a robust analysis of all planning scenarios that could answer key planning questions. A significant amount of analysis went into selecting the demand- and supply-side resources for portfolio analysis, which is summarized below. Figure 3-3 illustrates how demand and supply resources are integrated into our portfolio analysis.

Figure 3-3
Constructing Integrated Portfolios



Demand-side Resource Alternatives

PSE utilized a comprehensive screening process to aggregate demand-side resources from a potential 1700+ individual energy efficiency and other demand side measures down to five "bundles." This process is described in Chapter 5. Savings for all demand-side bundles resulted from energy efficiency, distributed generation, fuel conversion, and demand response measures. Demand response measures were used to calculate avoided peak demand rather than avoided annual energy requirements.

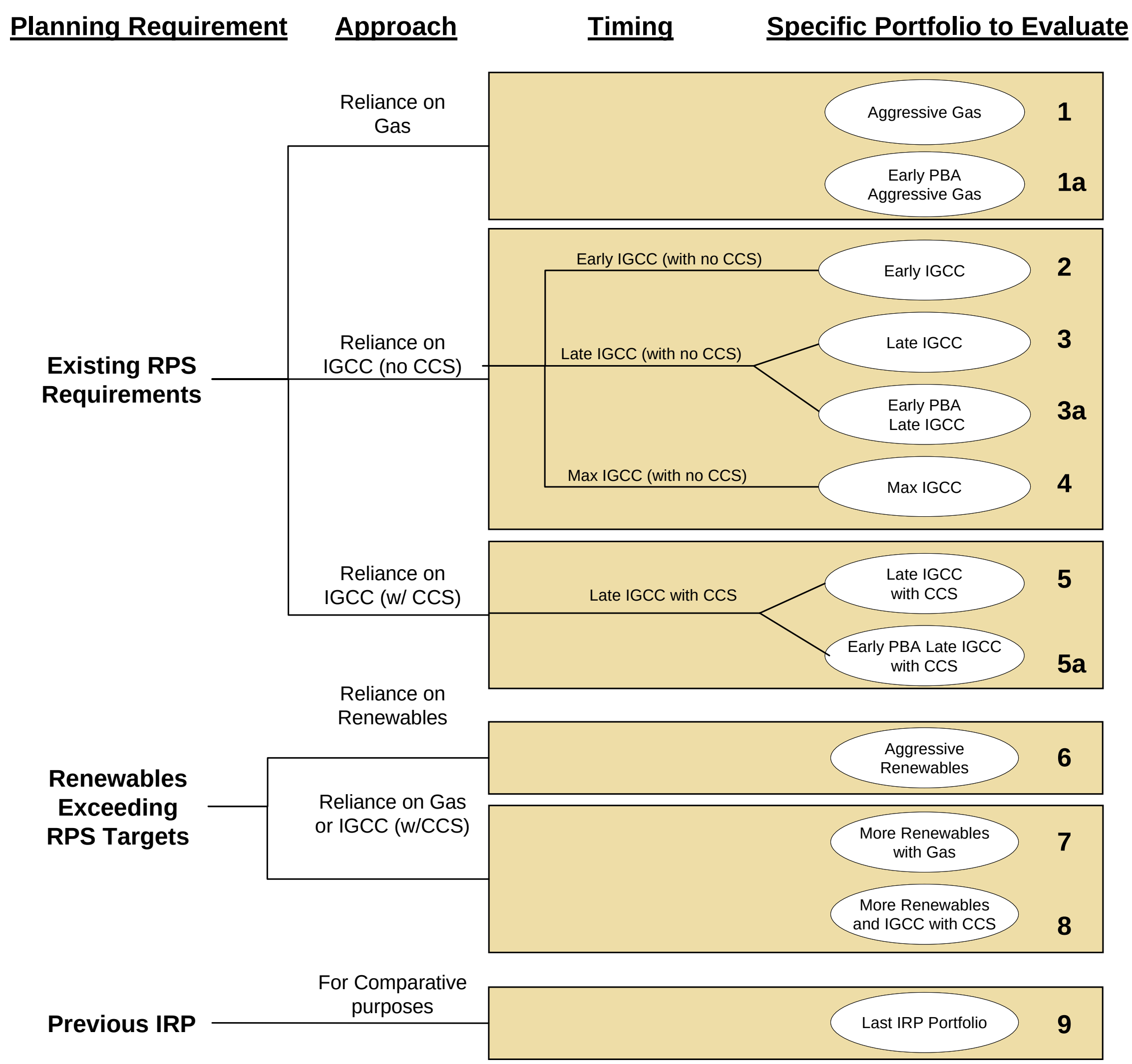
- Demand-side Bundle 1: The Current Trends bundle, which assumes avoided costs of $89.82 per MWh with total savings of 439 aMW.
- Demand-side Bundle 2: The High Avoided Costs bundle assumes avoided costs 25% higher than the Current Trends bundle for total savings of 464.5 aMW.
- Demand-side Bundle 3: The Low Avoided Costs bundle assumes avoided costs 10% lower than the Current Trends bundle for total savings of 419.9 aMW.
- Demand-side Bundle 4: The Low Growth bundle assumes avoided costs 14% lower than the Current Trends bundle and total savings of 404.4 aMW.
- Demand-side Bundle 5: The Green World bundle assumes avoided costs 14% higher than the Current Trends bundle for total savings of 450 aMW.

Supply-side Resource Alternatives

The supply-side alternatives for the resource portfolios are made up primarily of varying amounts of renewables, intermediate term power bridging agreements (PBAs), natural gas-fired combined cycle combustion turbines (CCCT), and coal-fueled integrated gasification combined cycle turbines (IGCC) with and without carbon capture and sequestration (CCS). Such portfolios introduce various resources at different times and in different quantities. Several include small changes in composition that stem from our desire to understand how certain assumptions might influence analytical results. For example, we wanted to find out how the use of short-term power bridging agreements (PBAs) affected expected costs for each of the different portfolios. PSE designed the portfolios to provide insight to how different levels of renewable energy requirements might evolve, what the cost and risk exposure to different fuel choices might be, and the sensitivity of results to the timing of these key decisions.

These alternatives are illustrated schematically in Figure 3-4.

Figure 3-4
Diagram of Electric Analysis Portfolio



Integrating Resources into Portfolios

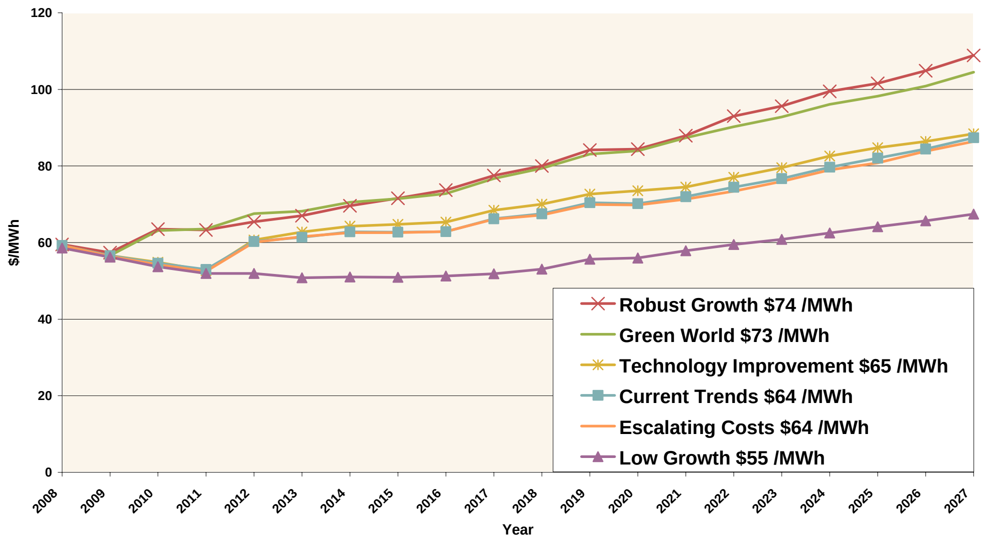
Integrated resource portfolios were generated by combining various demand-side bundles with the sets of supply-side elements. Rather than use all five demand-side resource bundles, we chose bundle 1 (Current Trends) along with bundles 2 and 4, which were the high and low cost bookends. This exercise is described in more detail in Chapter 5.

C. Electric Price Forecasts

The AURORA model was used to create separate electric market price forecasts for each of the six scenarios. The forecasts calculated by AURORA are based on specific economic, marketplace, and demand assumptions pertaining to each scenario. Different sets of input assumptions are designed to represent the different planning scenarios described above. A table summarizing key input assumptions is available in the Electric Analysis Appendix.

A comparison of the six electric price forecasts appears in Figure 3-5 below. Tables showing the monthly prices for all of the forecasted scenarios appear in the Electric Analysis Appendix.

Figure 3-5
Comparison of Annual Mid-C Price Forecasts for Six Electric Scenarios



Electric price forecasts are grouped tightly around one key input assumption: natural gas prices. Robust Growth and Green World prices are very similar, with levelized prices at $74/MWh and $73/MWh, respectively. Both use the same high gas price forecast. Current Trends, Technology Improvement, and Escalating Cost electric price forecasts are also tightly clustered in the range of $64-65/MWh. These scenarios also share a common gas price assumption. The electric price forecast for Low Growth is the lowest at $55/MWh, based on a low gas price assumption. While other input assumptions for PSE's portfolio analysis play a role, natural gas prices are the single largest determinant for the electric market price forecast. This result is consistent with natural gas-fired resources serving as the marginal market resource most of the time.

III. Gas Analysis Components

A. Gas Scenarios

Natural gas and electric resource planning analyses utilized consistent assumptions. Two kinds of studies were performed in our gas planning analysis. First, we performed gas resource planning analysis to meet the growing needs of our gas sales customers. Second, we performed a planning analysis on electric generation fuel requirements. The starting point for our generation fuel analysis was the gas load that results from the lowest reasonable cost electric portfolio. That is, after completing the electric analysis and selecting the lowest cost portfolio, we captured the gas usage from the electric dispatch model and applied our gas optimization model to these results. This allowed us to examine generation fuel use more closely than is possible in electric modeling alone.

Gas sales analysis was performed in the context of Current Trends, Green World, Robust Growth, and Low Growth planning scenarios. Technology Improvement and Escalating Costs were not replicated in the natural gas resource planning analysis, since those two scenarios are focused on factors mainly relevant to electric generation. The generation fuel requirements study was performed with Current Trends gas prices and the Current Trends dispatch of generation fuel.

Figure 3-6 summarizes the gas planning scenarios.

Figure 3-6
Gas Scenarios Summary Table

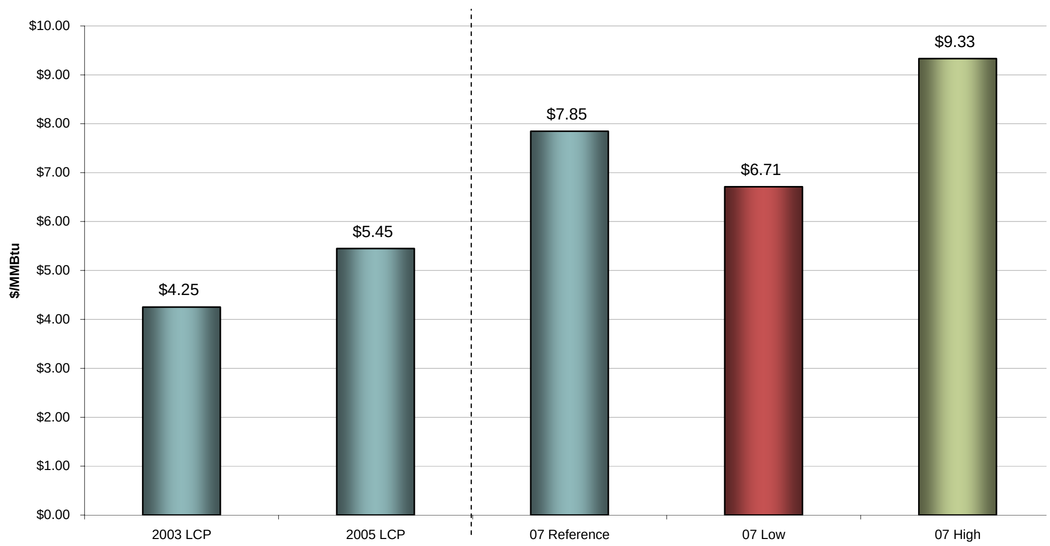
	Theme	Gas Demand	Gas Prices
Reference or Base Case	Current trends continue.	Base case customer growth and use/customer.	Mid-Prices: Global Insights Reference Case
Green World	National gas demand driven up, driving up prices.	Base case customer growth and use/customer.	High Prices: Global Insights High Scenario
Robust Growth	Local economy grows faster than expected.	High customer growth rate and higher use/customer.	High Prices: Global Insights High Scenario
Reduced Growth	Low regional and national economy.	Low customer growth rate and lower use/customer.	Low Prices: Global Insights Low Scenario
Generation Fuel Study	Current Trends Continue	Gas demand for generation fuel from lowest resaonable cost portfolio	Mid-Prices: Global Insights Reference Case

B. Gas Price Forecasts

As mentioned above in the scenario discussion, gas prices used for resource planning analysis were a combination of forward market prices, followed by fundamental forecasts. Fundamental forecasts were acquired from Global Insight, a well known macroeconomic and energy forecasting consultancy. Global Insights 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 20-year levelized gas prices, including forward market prices used in the resource planning analysis. Comparisons of gas prices from the 2003 and 2005 resource plans are also depicted. Figure 3-7 demonstrates that current market and forecast gas prices have increased significantly in the past four years.

Figure 3-7
Levelized Sumas Hub Gas Price Forecasts, 2008-2027



Reference gas prices for the 2007 IRP are 85% than assumed in the 2003 Least Cost Plan.
Even low gas prices for the 2007 IRP are 58% higher than the reference case from the 2003 Least Cost Plan