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2017 PSE Integrated Resource Plan

Planning Environment

This chapter reviews the conditions that defined the planning context for the 2017 IRP.

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1. GREENHOUSE GAS EMISSIONS

At present, the future of greenhouse gas (GHG) regulation at the federal, state and local levels is uncertain at best. However, PSE cannot ignore the possibility that *some* level of change to regulatory policies regarding carbon-emitting generating resources and/or the use of natural gas as a heating source is likely to occur during the 20-year planning horizon of this IRP. Summarized below are some of the current regulatory initiatives that have the potential to impact the operation of PSE's existing power supply portfolio, future resource acquisition decisions and the operation of PSE's natural gas distribution system.

Clean Air Rule

The Clean Air Rule (CAR) promulgated by the Washington State Department of Ecology (DOE) is effective beginning in 2017. This rule is intended to address GHG emissions from in-state non-mobile sources, petroleum product producers and importers, and natural gas distributors. While CAR would establish emission standards to "cap and reduce" GHG emissions, it would not be a full "cap and trade" program like California's existing program. New emission sources, like new baseload gas plants, are permitted. CAR would allow covered sources to create emission reduction units (ERUs) if a source's emissions levels are below the targets set by the state – or to purchase ERUs if the source operated above the targets. An emissions source may then bank its ERUs for future use or sell them. With CAR just beginning in 2017, the volume of ERUs is unknown at this point and likely very limited. So, instead of sources having the option to purchase large volumes of CO_2 credits to offset their physical GHG emissions (as in California's program), compliance with CAR will be achieved primarily through actual GHG reductions or through the purchase of carbon credits available from emissions programs outside of Washington state.

The CAR program has a significant impact on both PSE's existing power resource portfolio and any new PSE resource additions, because it will generally increase the costs of carbon emitting generating resources like natural gas-fired plants compared to carbon-free resources such as wind and solar. PSE's natural gas distribution customers will also be affected because PSE will need to purchase ERUs (if available) to offset a portion of its customers' natural gas usage. Quantifying the potential financial impacts of CAR on PSE and its customers is challenging, given that prices for ERUs will likely be established via a market-based negotiation process that could result in PSE's actual compliance costs being significantly higher or lower than forecast.

CAR is the subject of several lawsuits challenging the validity of the rule, but the rule is in effect nevertheless. Accordingly, PSE needs to be prepared to incorporate CAR into its long-term electric and natural gas resource planning processes. This situation necessitates that PSE maintain flexibility in evaluating the risks associated with the potential acquisition of any new power supply resources until the full impacts of CAR are known and quantified.

Clean Power Plan

The federal Clean Power Plan (CPP) applies carbon costs to all existing and new baseload generating facilities located in the U.S based upon a set of state-specific GHG reduction targets and associated compliance plans. Potential consequences for PSE include higher operating costs for its existing fleet of natural-gas and coal-fired generating plants as well as increasing the forecasted cost of adding new carbon-emitting resources. The CPP could be implemented as a cap and trade system in which trade may or may not be implemented across different states. Or, it could be implemented as a carbon intensity system that targets a tons per MWh metric in which some elements of interstate trading may or may not be implemented. Different applications of the CPP could lead to different results.

Twenty-seven states and other entities have filed lawsuits to block the Environmental Protection Agency's (EPA) implementation of CPP on the grounds that the EPA lacks the authority under the Clean Air Act to regulate GHG emissions. In 2016, the United States Supreme Court stayed the EPA's implementation of CPP pending judicial review (the case is currently pending in the D.C. Circuit Court). In addition, the current federal administration issued an Executive Order on March 28, 2017 in favor of energy independence that calls for review of specific regulations affecting the energy industry including the Clean Power Plan. On April 4, 2017, the EPA announced that it is reviewing CPP regulations, and if appropriate, will initiate proceedings to suspend, revise or rescind the CPP. While implementation in the short term is uncertain, it is still possible (and likely) that some form of the CPP could be implemented during the 20-year planning horizon of this IRP. This situation again requires that PSE maintain flexibility in the evaluation of, and potential acquisition of, new power supply resources while the future of the CPP is being debated.

Other State and Local Government Policies

In addition to the EPA's proposed CPP and Washington state's CAR, various entities within the state, including several local government bodies, have recently adopted or are currently discussing additional carbon-reduction initiatives. For example, Washington voters rejected a ballot initiative in 2016 to create a statewide carbon tax, but several state lawmakers continue to support this concept. In addition, stakeholders are currently reviewing carbon pricing policies, and have filed three such measures with the Office of the Secretary of State. Local jurisdictions have also discussed potentially restricting the development of new carbon-emitting resources, including coal and natural gas-fired combustion turbines. King County's Strategic Climate Action Plan and King County Cities Climate Collaboration (K4C) set renewable energy goals to use 100 percent carbon-neutral energy in county operations by 2025, to phase out coal-fired electricity sources by 2025 and to limit new natural gas based electricity power plants. The City Councils of Seattle and Olympia have passed resolutions calling on PSE to stop operating Colstrip by 2025. The City of Edmonds City Council recently approved amendments calling for city-owned buildings be powered completely by renewable energy by 2019 and for the city's community electricity to come from renewable sources by 2025, and a number of counties and cities have also passed similar resolutions. These are not binding regulatory requirements, but clearly demonstrate a significant number of the political leaders in our service territory are concerned about climate change and the role Colstrip plays in it.

Changing Customer Priorities

Beyond the political activities mentioned above, PSE has been partnering with customers seeking ways to meet their electricity needs with renewable resources. These include large commercial customers, small to mid-size businesses and residential customers. To serve these customers, PSE has developed a number of elective programs that are approved and monitored by the WUTC such as the Green Direct, Solar Choice and Green Power Programs, and we are committed developing further such products. These programs are important, because they provide customers with the ability to express their own preferences about the energy used to supply them, beyond the standard regulatory compact that requires PSE to minimize costs. Our first offering of Green Direct, marketed to larger commercial customers and government entities, was very successful. This program directly supported development of the Skookumchuck wind facility. PSE is working toward a second open season for the Green Direct Program and will continue to look for ways to partner with customers in meeting their energy needs.

2. REGIONAL RESOURCE ADEQUACY

Because PSE relies on more than 1,600 MW of wholesale market purchases to meet its current and forecasted energy and peak demand obligations,[1] we must monitor regional resource adequacy issues closely and be prepared to modify our purchase strategy accordingly should changing conditions warrant. To this end, PSE will continue working in conjunction with other regional planning entities such as the Northwest Power and Conservation Council (NPCC), Bonneville Power Association (BPA), and the Pacific Northwest Utilities Conference Committee (PNUCC) in order to improve existing analytical tools and to develop consensus assumptions for use in regional resource adequacy assessments.

For more than a decade, the Pacific Northwest region's large capacity surplus has kept wholesale power prices relatively low and made these existing resources a lower cost alternative to filling PSE's peak capacity need than building new generation. However, the long-term load/resource studies developed by the region's major energy organizations, NPCC, PNUCC and BPA,[2] while they differ in some details, generally point in the same direction: The current Pacific Northwest (PNW) energy and capacity surplus is expected to cross over to deficit at some point in the next decade unless new supply-side and/or demand-side resources are developed. This IRP analysis is aligned to the analytical results of the NPCC's 2016 Regional Resource Adequacy Assessment, but that assessment was updated in July of 2017.[3] The 2017 update forecasts the region will be short of the 5 percent LOLP target by 2022, requiring 400 MW of effective capacity to achieve the target under the NPCC base assumptions.

Fortunately, recent evidence suggests that the region is in the process of adding new resources (mainly in the form of additional investments in conservation) to fill this forecasted resource gap. In fact, NPCC staff highlighted that if the region follows the guidance from the Seventh Power Plan, it will be adding approximately 600 MW of conservation every year. In addition, regional utility load forecast growth rates are continuing to trend downwards, thereby also closing some of the projected gap. Also, the amount of power that can be reliably imported into the region during winter and summer peak load events may be higher than the figures currently being used in the NPCC's resource adequacy model. Finally, PSE's shift to a 5 percent LOLP metric in this IRP for its capacity planning standard (as opposed to the Value of Lost Load approach used in the 2015 IRP) has resulted in a higher level of reliability being assigned to wholesale market purchases. While there is still some level of risk to PSE in relying on up to 1,600 MW of wholesale market

1 / See Chapter 6, Electric Analysis, and Appendix G, Wholesale Market Risk, for more detail on wholesale market purchases and peak need.
2 / These studies are included in Appendix F, Regional Resource Adequacy Studies.
3 / https://www.nwcouncil.org/media/7491213/2017-5.pdf

purchases to meet resource need, this risk appears to be significantly reduced from the level presented in the 2015 IRP.

The extensive analysis performed in the 2017 IRP indicates that PSE wholesale market purchases above the 1,600 MW level, when paired with additional firm transmission import rights that PSE may have during peak load events, is both a reliable and cost-effective way for PSE to meet its forecasted resource need when compared against other available new resource alternatives. These conditions allow PSE to maintain a considerable amount of flexibility regarding future resource acquisitions while also allowing it to effectively manage other uncertainties in the planning environment such as future GHG regulation, climate change, potential changes in customer behavior and the increasing effectiveness of emerging and maturing technologies.

These are all reasons for increased confidence, however, uncertainties remain. Should the region be unable to achieve forecasted conservation targets, should the specific timing of some of the region's coal-fired generating plants change, or should unexpected demand-side or supply-side shocks render the region short of resources, risk to PSE's customers would increase substantially. PSE has also expressed concern that the 5 percent LOLP metric, which measures the likelihood of deficit events, may not adequately describe the duration or magnitude of potential regional deficit events. The diversity of PSE's resource portfolio means that we would be able to mitigate some of these effects by using thermal resources to fill gaps during non-peak hours, but we would still be unable to meet peak need under such circumstances. For this reason, it may be advisable to develop a supply-side resource option that could be built in less than two years, in case wholesale market risk changes significantly.

3. CLIMATE CHANGE

Climate change is happening at a global level,[4] and these changes are affecting the Puget Sound region. Already, the region has experienced "long-term warming, a lengthening of the frost-free season, and more frequent nighttime heat waves,"[5] according to a study by the University of Washington.

Climate change could affect PSE's power system operations and the IRP planning process in a number of ways. Changes in temperature, the frequency and duration of extreme weather events, hydro conditions, customer energy use and the number of customers served, will affect how much power PSE needs for its customers' energy demand and how much power is needed at times of peak energy usage.

PSE needs detailed climate projections to forecast how climate change will affect our service territory to understand and plan for the range of probable futures so that we can adapt to the climate of the future. By detailed climate projections, we mean fundamental, scientific climate models, not just statistical analysis of recent trends.

At this time, there is not enough data to do a robust analysis of how our service territory, peak need, energy demand and conservation programs will change as a result of climate change. In the next section, we describe the data we believe is needed to do robust modelling of how climate change will affect our service territory and therefore our long-term capacity needs.

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4 / IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

5 / Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. State of Knowledge: Climate Change in Puget Sound. *Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D*

Impacts on Peak Need

Changes in weather are important for the IRP planning process because PSE forecasts are based on "normal" temperatures (last 30 years) and "normal" hydro conditions (1929 - 2008). If those normals are changing, we need to plan for that change and account for it in our modelling.

First and foremost, we need to understand how peak temperatures may change, because peak demand drives the need for additional capacity to meet the peak needs of both electric and natural gas service customers. Forecasting peak need is critically important for resource planning, and therefore understanding how extreme weather events may change is vitally important for integrated resource planning. We need data that will enable us to better understand these key questions:

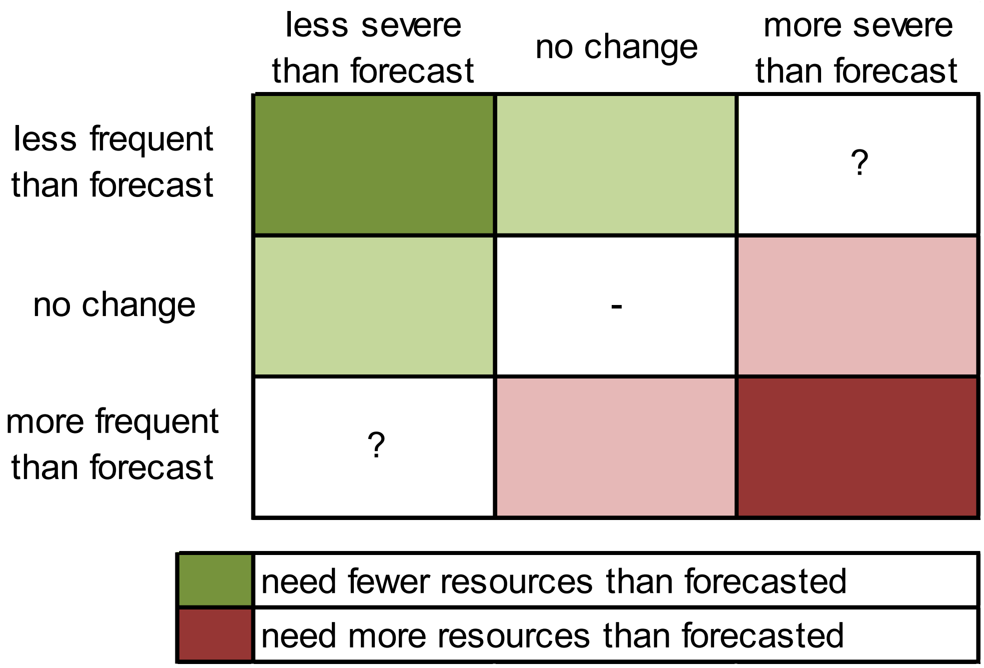
- Are changes in extreme temperatures expected to change summer and winter peaks?
- Are sustained peaking events expected to increase or decrease?
- How will the severity and frequency of extreme events change?
- Will changes in the jet stream air currents mean arctic air dips into the region more frequently?[6]
- Will there be a change in humidity in the future?
- Could PSE's service territory become a summer peaking utility, and if so, when?

A number of global climate models exist and could be downscaled to this region, but at this time it is not clear whether they can provide the needed information; simply scaling down large-scale averages is not sufficient.

Figure 3-1 shows the possible consequences to PSE of changes in extreme weather events. If extreme weather becomes more frequent and more severe than forecast, then PSE will likely need more flexible resources to respond to those events. If extreme weather events become less frequent and less severe, PSE will likely need fewer resources to respond. If there is no change in frequency or severity, we would expect no change in the planning process. However, if extreme weather events are more frequent but less severe, or more severe but less frequent, we need to understand these events better to forecast how they will affect our existing portfolio and new resource decisions. Currently, PSE is a winter peaking utility, however, the concept applies equally should climate change transition PSE to a summer peaking utility.

6 / Mooney, Chris "The Arctic is showing stunning winter warmth, and these scientists think they know why." The Washington Pos,t 23 December 2016, https://www.google.com/search?q=The+Arctic+is+showing+stunning+winter+warmth&oq=The+Arctic+is+showing+stunning+winter+warmth&aqs=chrome..69i57j69i60.1774j0j7&sourceid=chrome&ie=UTF-8

Figure 3-1: Possible Effects of Climate Change on Extreme Weather



Impacts on Energy Need

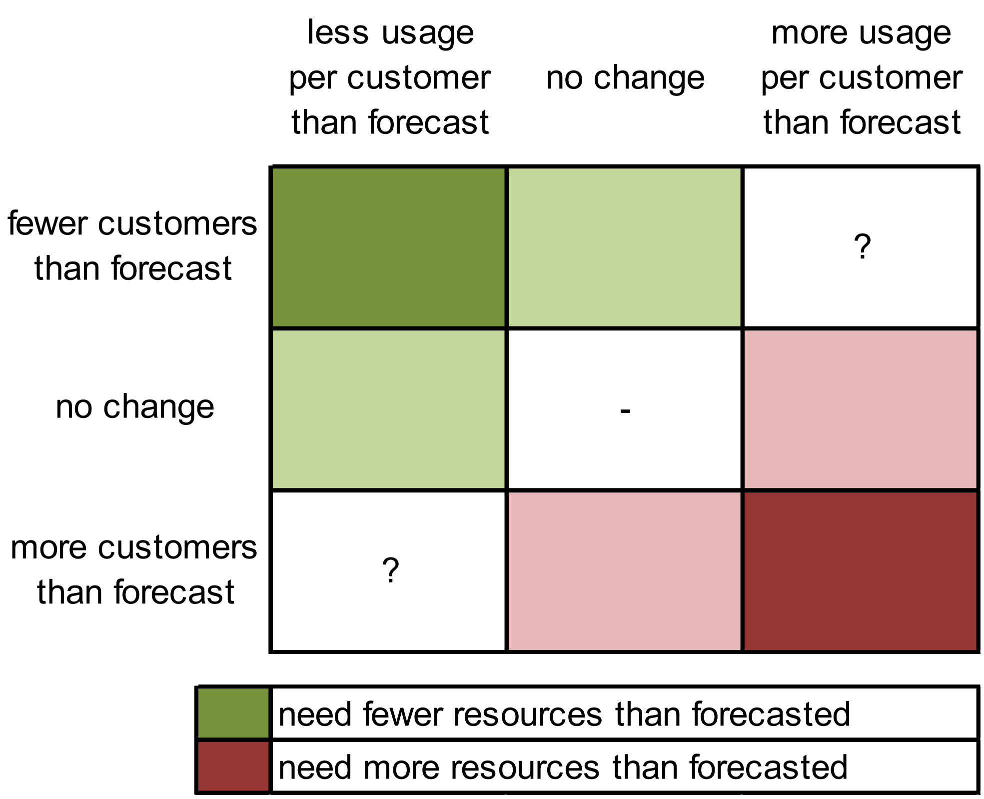
In addition to impacting peak need, climate change may also impact customer load growth in two ways: by changing customer energy usage patterns, and/or by changing the number of customers we can expect to serve.

First, we need data to better understand how climate change will affect individual energy usage. For example: How will customer energy usage change seasonally? Will there be an increase in air conditioner saturation over time, causing more energy usage at a given temperature? Will we see more solar PV installations, thus lowering customer demand in the summer? Will we see additional air conditioning load in the summer? PSE is working to develop an end-use load forecasting model that could be used to analyze energy usage at the customer level. Also, there are regional efforts to collect new end-use data that could be used in the model PSE is developing.

Second, we need data to better understand how climate change will affect the number of customers that PSE serves. How will regional, national or global changes affect migration patterns into or out of this region? Will other locations become less hospitable (due to sea level rise, desertification or increased temperatures) forcing people to move to more hospitable places, such as the Pacific Northwest as climate refugees? Will changes in the economy or the number of jobs cause people to move into or out of the service territory?

Figure 3-2 shows possible effects of climate change on energy demand. If PSE has more customers and higher use per customer than forecasted in a given season, then PSE may need more resources than forecasted. Similarly, if there are fewer customers and lower use per customer PSE will need fewer resources. However, the impact on resources is more uncertain if we see higher use per customer and lower customer counts or vice-versa.

Figure 3-2: Possible Effects of Climate Change on Loads



Impacts on the Hydroelectric System

Climate change may also bring changes to the regional hydroelectric system, changing the timing of runoff, the amount of runoff, or both. Changes to the hydroelectric system could affect PSE's hydroelectric generation as well as Mid-C wholesale prices and regional energy availability. Assuming that PSE and the Pacific Northwest region remains winter peaking, direct effects to PSE's peak capacity need should be minimal; that is, we could anticipate sufficient hydro power to shape generation to meet peaking needs in the winter. Changes in other seasons, however, could also impact operations. For example, changes in operating conditions on the Columbia River could reduce the amount of energy and capacity available in the summer. In addition, power markets could be impacted by larger minimum flows requiring longer periods of time to manage dissolved gases and water temperature for fish. This could lead to a loss of flexibility and ancillary services from the hydro sector.

To understand changes to the hydroelectric system we need to understand changes in snowpack and runoff and how these changes will affect hydro operations and the re-shaping of natural stream flows across the year. This could include changes in daily temperatures, precipitation changes, and seasonal weather trends and new environmental constraints on the hydro system. Also, it is possible that climate change could affect withdrawals of water from the region's reservoirs for non-power purposes such as irrigation or domestic water supply.

Understanding these changes will be useful for energy planning and planning for ancillary services, especially in the summer when natural stream flows into the hydroelectric system are at their lowest point. If we see an earlier peak and less water overall in the system, we would expect much less water and less energy from the hydro system in the summer.

There are regional efforts through BPA, the U.S. Army Corps of Engineers, and the Bureau of Reclamation to better understand the effects of climate change on the Columbia River hydroelectric system in terms of timing, overall annual runoff volumes, and the hydro system's ability to meet non-power constraints. PSE will be following these efforts closely to better understand how climate change will affect this regional resource.

Next Steps

This is not an exhaustive list of how climate change could affect PSE, its resources or the service territory. (For example, changes to cloud cover, winds, or wildfire could affect PV installation, wind generation or transmission lines.) We do not need a complete understanding of how climate change will unfold before starting to model some of its effects on the PSE system, however, we do need more information to perform a robust analysis, particularly fundamental, scientific climate change models that focus on the region. Developing or getting access to regional forecasts that will give us the information outlined above is a priority for PSE.

4. EMERGING RESOURCES/ENERGY STORAGE

Previous IRP's have included emerging resources and energy storage devices, however, PSE's ability to fully evaluate the potential benefits and associated costs of these resources was hampered by several factors. These include: 1) lack of historical industry operating data for grid-scale applications of these technologies, 2) a wide range of cost estimates for some devices, 3) uncertainties regarding potential future cost reductions and/or efficiency gains, 4) difficulties in valuing some of the attributes that emerging resource/energy storage devices can provide due to a lack of available pricing data, and 5) lack of an analytical tool that would allow PSE to fully incorporate the flexibility value of emerging resources/energy storage alternatives in its IRP planning process.

While some challenges remain (such as the lack of some historical pricing data), PSE has made great strides in this IRP in expanding its analysis of emerging resources/energy storage devices. In particular, PSE's acquisition of the PLEXOS model now allows PSE to model both conventional resources and energy storage devices down to a five-minute time interval as opposed to the hourly time interval previously used for PSE's evaluation of energy storage technologies. The addition of PLEXOS allows PSE to model the intra-hourly operational characteristics of both conventional resources and energy storage devices; this capability, in turn, expands PSE's ability to quantify the full value stream that energy storage devices can bring to PSE's resource portfolio.[7]

The 2017 PSE IRP modeled five different energy storage devices that incorporate three different technologies and operating characteristics: lithium-ion batteries, vanadium-flow batteries and pumped hydro storage.[8]

7 / See Appendix H, Operational Flexibility, for a detailed summary of the PLEXOS model and PSE's operational flexibility analysis.
8 / Chapter 6, Electric Analysis, describes each of the energy storage alternatives analyzed.

While energy storage technologies other than batteries and pumped hydro storage exist – such as compressed air and flywheels – PSE did not model these technologies for several reasons. Compressed air storage facilities can be developed only at sites that have very specific geological conditions, which severely limits where these types of plants can be sited in the Pacific Northwest. And, while flywheel storage facilities can potentially be sited at a large number of different locations, this technology has yet to be proven in grid-scale operations. PSE therefore focused its evaluation of energy storage devices that: 1) are commercially available in grid-scale operations, and 2) can be reasonably sited in PSE's service territory and/or the Pacific Northwest region.

Battery storage technologies, in particular, are maturing, and manufacturing costs are being driven down by economies of scale, especially for lithium-ion batteries. In fact, the results of PSE's operational flexibility analysis for this IRP indicate that batteries are very close to being a cost-effective resource for PSE's portfolio.[9] PSE will continue to fine tune its flexibility analysis and the role that energy storage devices may have in future resource portfolios. In addition, it will be important for PSE to assemble additional data regarding the performance characteristics of energy storage technologies in actual utility grid-scale applications and to assess PSE's potential need for additional system flexibility as more intermittent resources are integrated into PSE's Balancing Authority Area.

9 / See Appendix H, Operational Flexibility for additional details.

5. GAS SUPPLY AND PIPELINE TRANSPORTATION

Natural gas supplies in the basins that serve PSE continue to exceed expectations due to the abundant supply of natural gas from shale formations and improving production techniques, despite the decreased likelihood of an LNG export terminal in the region. Long-term projections of natural gas's affordability continue to augment the role of natural gas in our region's environment and economy. Natural gas remains a good economic value as an energy source, especially compared to its price levels of just a few years ago and the price of substitute fuels like oil. This remains true even in the current environment of lower-priced oil.

Though the regional gas transportation system is adequate to meet current demand, it is likely to experience increasing stress as gas customer growth continues – for example, if more of the region's electric generation requires natural gas for fuel, if liquefied natural gas (LNG) exports materialize, if large industrial uses such as methanol plants are developed, and as the transportation sector[10] continues to adopt natural gas as an attractive fuel option. However, increased demand for natural gas could be offset by new carbon policies, such as CAR. Significant additions of gas peak loads will certainly require expanded pipeline capacity for certain locations (see Chapter 7, Gas Analysis). Given the scale of new industrial demand, it is important to note that large new industrial gas users may have more control over timing and location of future infrastructure expansions than existing users, including utilities.[11]

10 / *In this context, transportation sector includes maritime and heavy truck shipping and CNG vehicle use.*
11 / *Northwest Gas Infrastructure Landscape Looking Forward, a paper produced by NWGA and PNUCC, discusses the development of large industrial gas loads. http://www.nwga.org/wp-content/uploads/2015/07/Northwest-gas-inf-FINAL-Jul-2015-v21.pdf*

6. THE ACQUISITION PROCESS

The IRP provides a forecast of demand- and supply-side resources that could be used to meet resource needs. When PSE must fill an actual capacity need, it begins an acquisition process in which specific resource decisions must be made in a dynamic environment. In this process, PSE considers the IRP results along with several additional factors. These factors include the actual availability and cost of proposed resources, specific issues related to proposed resources such as the availability of transmission and gas transportation, changing needs and external influences.

A utility can acquire resources in a number of ways: through competitive bids in a request for proposals (RFP) process, by evaluating unsolicited or opportunistic offers, by constructing resources, by operating conservation programs or by purchasing power with negotiated contracts.

WAC 480-107-015 outlines the timing of an RFP. Under the WAC, an RFP must be filed if the IRP shows a capacity need within the first three years of the IRP's planning horizon, though PSE can issue an RFP for a need further out than three years. The process unfolds as follows.

PSE issues an RFP to interested parties and posts it on its website. The proposals submitted are evaluated in a two-phase process using these criteria:

- Compatibility with resource need
- Cost minimization
- Risk management
- Public benefits
- Strategic and financial benefits.

Phase 1 screens proposals to eliminate those with high costs, unacceptable risks or feasibility constraints. It uses a quantitative analysis to screen bids and a qualitative analysis to identify fatal flaws. Phase 1 produces a short list of candidates that advance to Phase 2 of the RFP process. In general, proposals on this list have positive economic benefits and no fatal flaws.

Phase 2 is a due diligence process. Input assumptions such as load and gas prices are updated as needed, more extensive quantitative analysis is performed to evaluate resource portfolios using various assumptions, and qualitative analysis is conducted based on the evaluation criteria. Phase 2 produces a list of proposals with the lowest reasonable cost and risk that best meet PSE's identified resource and timing needs.

PSE officers are kept apprised throughout the process, and updates are provided to the company's Energy Management Committee[12] (EMC). When Phase 2 is completed, a short list of proposals is formally recommended to the EMC for approval. PSE then enters negotiations with short-listed counterparties, and if agreements are reached then possible acquisitions are submitted to the EMC and, in some cases, the Board of Directors for approval. If an acquisition is made, PSE requests a prudence determination from the Washington Utilities and Transportation Commission (WUTC) when the company proposes in a rate proceeding to include the new resource's costs in its rate base and revenue requirement.

HOW RESOURCE SIZE IS DETERMINED. The capacity and RPS needs are determined in the IRP and updated on an ongoing basis as new information becomes available. The IRP provides a theoretical picture of the future resource portfolio using a range of generic resources that could be used to meet the capacity and RPS needs under different sets of assumptions. The size and cost of each generic resource are based on what is currently available in the market for that type of resource.

An RFP involves evaluating specific proposals submitted by counterparties as well as internally developed proposals for self-build options. In both the IRP and RFP, PSE uses the Portfolio Screening Model (PSM) to optimize PSE's energy portfolio by minimizing total portfolio cost subject to the two constraints of meeting peak capacity need and the RPS requirement. In both the IRP and RFP analyses, new resources are added in blocks to meet load over the 20-year planning horizon, which results in excess capacity when new resources are added. Gradually, this excess capacity decreases as load grows until there is another build requirement driven by peak capacity need. Evaluation of resource alternatives assumes that excess energy and RECs can be sold into the market. A given bid is evaluated based on its impact on total portfolio cost, its ability to meet the capacity and RPS needs,

12 / PSE's EMC provides policy-level and strategic direction for the company's energy resource planning, operations, portfolio management and acquisition decisions.

and qualitative factors. Results are re-evaluated as time passes and new information becomes available.

For example, with respect to how large a wind farm should be, PSE must consider multiple factors when deciding how many turbines to install. Factors that influence this decision include:

- **The type and size of turbine.** This impacts the spacing of turbines on the site and the number that can be installed.
- **Geography of the site.** This can dictate how spread out the turbines are, the number of turbines and the amount of infrastructure such as substations, transmission and roads that are required. The equipment is arranged to be as efficient as possible.
- **Schedule.** A short construction period that includes two summers and one winter is preferable to a longer construction period so that the assets can be placed into service as soon as possible.
- **Interconnection agreements.** Transmission requirements can influence the timing and planning for how the work is done.
- **Contracts with counterparties for delivery of materials and construction**. The turbine supply agreement and balance of plant agreements need to be integrated to avoid gaps in the schedule.

A wind farm is planned to be large enough to capture economies of scale while being small enough to have a relatively short construction period. Some of the required infrastructure is the same for a plant ranging from 100 MW to 250 MW, so if the plant is on the larger side, there are economies of scale as fixed costs are spread over greater plant output. Beyond some size threshold, adding turbines would also require additional infrastructure and construction time, thus delaying the in-service date of the assets.