


# Integrated Resource Plan

**NOVEMBER 2016 - EXECUTIVE SUMMARY**





Our goal is to be our customers' trusted energy partner, meeting their need for safe, reliable, affordable electricity at home and in their businesses with increasingly sustainable energy solutions.

**PGE's integrated resource plans have always offered detailed technical analyses of our strategy for supplying the electric power our customers need.**

The analysis is an invaluable tool to help PGE, our regulators and our stakeholders evaluate the choices available to us, both near and long-term, as we strive to find the least cost, least risk path for delivery of reliable power while reflecting our customers' values and complying with public policy and regulatory mandates.

This IRP reflects an ongoing evolution of our efforts to continuously improve. In this plan, you'll see that we're adapting to changing policy as we look to Oregon's energy future.

In no small part, this is driven by the adoption of the 2016 Oregon Clean Electricity Plan. PGE was part of the diverse coalition of utilities, customer groups, and advocacy organizations that helped develop and support passage of the legislation. The OCEP puts us on a path to achieve the state's goals for carbon emissions reductions in the electricity sector by requiring us to serve 50 percent of our customers' demand for electricity from qualifying renewable resources by 2040 and eliminate coal from our customer energy mix by 2035.

The OCEP also reflects the direction we've seen unfolding for at least a decade, as concerns around global warming and other environmental issues have intensified. In 2006, PGE acknowledged that the utility industry needs to be part of the global warming solution and called for carbon regulation at the national level. In 2007, we joined with stakeholders to craft and support adoption of Oregon's original renewable energy standard. And, our acknowledged 2009 IRP incorporated the discontinuation of the operation of Boardman on coal by the end of 2020, taking a broader view of likely future costs and risks associated with a generating resource that not long ago was viewed as a low-cost choice.

So how has all of this driven adaptation in our IRP? In short, we've changed the focus from meeting projected demand for power with acquisition of conventional resources we know we can deploy today, to achieving a significantly more renewable resource mix for tomorrow, based on new technologies and ambitious goals we've agreed are a priority for the communities we serve.





This doesn't mean we've compromised our commitment to an IRP that is based upon the best data, careful analysis, and realistic, workable options available. The action plan in this 2016 IRP is still firmly grounded in the practical balance of least cost and least risk actions that will meet our customers' energy needs. It does mean we've lifted our long-term vision to take full advantage of new technologies and markets for a smarter, more renewable and more flexible generating portfolio and grid – and to create more active partnerships with our customers – so we can meet the mandates of the OCEP and fulfill our customers' expectations of us as a utility that is pursuing our shared goals and vision for Oregon's more sustainable energy future.

The IRP is still a complex, technical document and the action plan still reflects a defined set of executable actions. I hope as you review the IRP, you'll agree that we've kept customers and community at the heart of our commitment to provide safe, reliable, and sustainable electricity at an affordable price, both today and tomorrow.

We thank everyone who participated in our public meetings and discussion during the development of the 2016 IRP, and look forward to a robust review of our conclusions and recommendations.

Sincerely,

A handwritten signature in black ink that reads "Jim Piro".

Jim Piro | President and Chief Executive Officer

# 2016 IRP Executive Summary

## Overview

### Planning for a renewable, reliable, affordable energy future

The future of energy in Oregon, the nation and the world is undergoing dramatic change. As our state's population and economy continue to grow, so does the demand for energy. At the same time, PGE and its customers are committed to reducing greenhouse gas emissions that contribute to climate change.

The 2016 Integrated Resource Plan is a strategic road map that reflects a future focused on more renewable sources of energy and fewer carbon-producing resources. Our 2016 IRP also retains our essential focus on providing our customers with safe, reliable, and affordable energy, using increasingly sustainable energy solutions.

This IRP puts PGE on track for achieving the state's carbon greenhouse gas reduction goals for the electric power sector through at least 2040, and ahead of schedule for integrating additional renewables.

PGE was part of a diverse coalition of utilities, customer groups and advocacy organizations that developed Oregon's Clean Electricity and Coal Transition Plan (Senate Bill 1547), passed by state lawmakers in March of 2016. The law sets goals for increasing renewable resources and eliminating coal as an energy source for our customers. PGE embraces those goals.

Under the law, 50% of the energy PGE delivers to customers must come from qualifying renewable resources by 2040. Today, about 15 percent of our energy comes from qualifying renewables. To meet this aggressive timeline for renewable power expansion, and to take advantage of production tax credits to keep costs lower for our customers, the plan calls for adding 175 average megawatts of new renewable resources, which is equivalent to 515 MW nameplate of new wind resources.

The new law also transitions Oregon off coal-fired electricity. The Oregon Public Utility Commission (Commission) previously acknowledged PGE's plans to stop burning coal at our Boardman Plant by year-end 2020. Under the new law, PGE will stop using any coal resources to serve our customers no later than 2035. This IRP, and future IRPs to follow, will address strategies for filling the shortfall created by this transition, increasingly using renewables to do so.

### Planning Process

The 2016 IRP uses new approaches and considerably more planning complexity to tackle challenging questions regarding the future of PGE's power supply. It is responsive to valuable recommendations we received from stakeholders following the 2013 IRP planning process, many of which challenged established thinking and required new analytical techniques.

PGE is committed to building stakeholder trust in its analysis and recommendations. We have been meeting with stakeholders for the past 18 months to discuss the strategies outlined in this IRP. This plan addresses their input, either by incorporating changes or providing more information to respond to questions, concerns, and suggestions.

This commitment to sharing information and building trust does not start and end with the 2016 IRP, but is integral to PGE's business. Just as the 2016 IRP has built off the recommendations and environment changes from the 2013 IRP, future IRPs will continue to benefit from a shared desire to continuously improve.

In order to better assess needs and capabilities for a system with more variable resources, PGE updated its modeling methodologies for determining capacity need and resource capacity contribution. The Company now bases its capacity need assessment on a robust reliability-based model, using an industry-standard loss of load expectation (LOLE) target. For all resource types, PGE uses the same model for estimating the capacity contribution of incremental resources to capture variability, correlation with load, benefits of locational diversity, portfolio effects, and declining marginal value.

Integrating the next generation of resources requires another evolution of planning processes and methods. As demand response and energy storage increase in scale and maturity, PGE is proactively developing ways to incorporate innovations into its integrated resource planning framework. As a leader in this effort, PGE continues to implement tools that improve our responsiveness to change, while allowing decisions to be made today based on the best available information to support resource decisions necessary to meet customers' long-term needs.

### Scenario and Portfolio Analysis

Scenario analysis provides the framework for assessing the economic risks associated with the different portfolios. Commission guidelines state the primary goal must be the selection of a portfolio of resources with the best combination of expected costs and associated risks and uncertainties for the utility and its customers.<sup>1</sup>

As a result of its scenario analysis, PGE identified one portfolio, called the Efficient Capacity 2021 portfolio, as the Preferred Portfolio. The Preferred Portfolio represents the set of resources that provides the best combination of expected cost and risk for PGE and its customers under the assumptions used in the modeling. However, any plan faces uncertainty and the Preferred Portfolio is not a pre-determined course of action. Alternative portfolio strategies may prove cost effective in future procurement analysis. In fact, four of the top-ranked portfolios had relatively comparable performance to one another. The precise resources modeled in the 2016 IRP will not be the exact resources available in the market at the time of acquisition, nor will they be offered at the same prices assumed in the modeling.

### Action Plan

The Action Plan in the 2016 IRP projects significant increases in energy efficiency, customer-side demand response, and renewable energy. As it does today, PGE will prioritize the implementation and dispatch of these sources before other generating resources.

Still, PGE will have a significant and growing gap between the power capacity needed to meet our customers' needs reliably and the resources available to do so. Much of the deficit is due to the

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<sup>1</sup> Commission Order No. 07-047.

need to generate power when renewable resources are unavailable, continued load growth, expiring long-term power purchase agreements, and ceasing coal-fired operations at Boardman.

Given PGE's obligation to reliably meet customers' needs, this IRP calls for a strategic use of new or existing dispatchable resources to complement and enhance our ability to add more renewable resources. New technologies give these plants the capability to quickly turn on and off to support the variability of renewable generation.

PGE has submitted an Action Plan that adheres to the Commission's procedural and substantive IRP Guidelines and complies with the requests and directives that the Commission issued in its order acknowledging PGE's 2013 IRP (see Appendix A, Compliance with the Commission's IRP Guidelines, and Appendix B, PGE's Compliance with 2013 IRP Order (Order 14-415)). After testing diverse portfolios under alternative projections, PGE is confident that the recommended Action Plan provides for the best combination of expected costs and associated risks, while retaining the flexibility to take advantage of market-driven resource innovations. It provides PGE the best opportunity to deliver safe, reliable and affordable energy to our customers in an increasingly sustainable way. The Action Plan takes full advantage of technologies and markets to enable a smarter, greener, more flexible generating portfolio and distribution system.

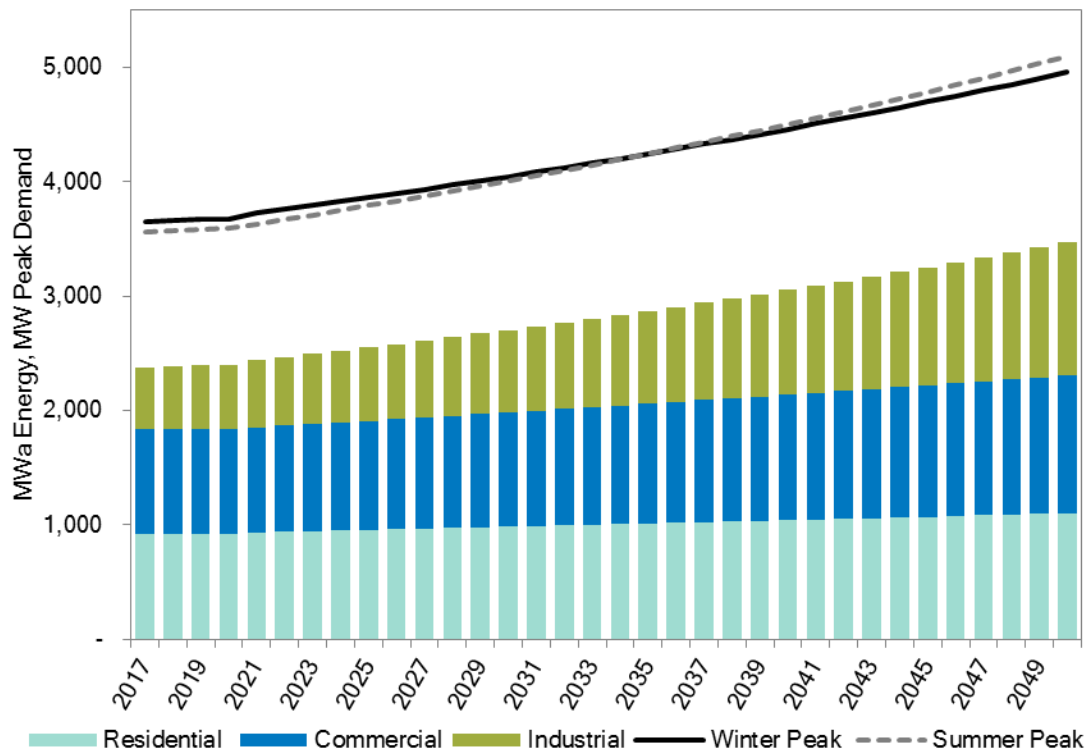
## Load Growth

Oregon's economy is a key driver of load growth projections. The state's economy has continued to improve since the filing of the last IRP, with employment surpassing pre-recession peaks and reaching growth rates over 3%. PGE's industrial sector performance and strong in-migration also have driven load growth projections above national averages.

In the short-term (2017 to 2021), PGE's load growth reflects the pace of economic growth in Oregon as forecast by the Oregon Office of Economic Analysis (OEA). It also reflects expansions currently underway among certain large customers. The long-term outlook for future economic, population and load growth in Oregon and PGE's service territory is also positive.

Energy efficiency and demand response have contributed significantly to reducing load growth. In recent years, PGE estimates that energy efficiency has reduced its deliveries approximately 1.5% per year.

The chart below shows PGE's projected load growth – 1.2% per year – when energy efficiency and demand response have been factored in.

**FIGURE ES-1:** Reference case forecast by class: 2017 to 2050

A detailed discussion of the load forecast and methodology is provided in Section 4.1, Load Forecast.

## Resource Needs

A key objective of the IRP process is to identify the gaps between existing resources and additional resources needed to achieve a sustainable, reliable and affordable energy future.

Our first task in assessing resource needs is to identify the contribution that energy efficiency and demand response can make.

### Adding energy efficiency — minimum of 135 MWa

Energy efficiency is a top priority resource in our portfolio planning, and it is the first resource PGE turns to for meeting customer needs. PGE is committed to helping our customers reduce their energy use, and we have a long history of working with the Energy Trust of Oregon to identify and acquire all available cost-effective energy efficiency measures. Through the combined efforts of the Energy Trust, customers and utilities, Oregon is a national leader in capturing energy efficiency.

From 2017 through year-end 2020, PGE plans an additional 135 MWa of EE savings on top of what has already been achieved, with continued EE growth in later years.

Energy efficiency is discussed in detail in Section 6.1, Energy Efficiency.

### **Adding demand response — 77 MW**

Demand response (DR) is another important way customers can help reduce PGE's resource need by reducing peak customer demand. Demand response will be an important part of PGE's total resource portfolio as we move to greater use of renewable resources.

Beyond PGE's own efforts in recent years to increase use of DR in our service territory, Senate Bill 1547 authorizes the OPUC to direct utilities to plan for and acquire cost-effective DR. PGE hired the Brattle Group to complete a comprehensive DR potential study. This study was used to develop an aggressive but attainable goal for DR acquisitions used in this IRP. These goals will be achieved through a diverse set of programs that target residential, commercial, and industrial customers. PGE plans to expand its DR resources to 77 MW (winter) and 69 MW (summer) through 2020, with continued growth in later years.

Section 6.3, Demand Response, provides information about PGE's DR programs and the DR potential study.

### **Adding renewables to meet Oregon's 50% RPS requirement — 175 MWa**

As the annual requirement for renewable energy increases from the current 15% to 50% in 2040, PGE will need to significantly expand its portfolio of RPS-compliant resources. RPS-compliant renewable resources can be in the form of energy production, Renewable Energy Credits (RECs), or both.

This IRP contains a robust analysis of all options for compliance, including the advantage of taking early action on physical compliance to secure tax credits and manage the use of unbundled RECs. The analysis shows that acting early, ahead of RPS requirements, is in the best interest of customers. For this reason the Action Plan calls for the addition of 175 MWa of new renewables (equivalent to 515 MW nameplate of new wind resources). The Company's strategy for complying with the RPS obligations is discussed in Section 10.6, RPS Compliance Strategies.

Even after capturing all available cost-effective energy efficiency measures, expanding the DR program, and making large renewable additions, PGE faces a deficit in resources to meet customer needs. As customers' energy use continues to grow, existing generation resource contracts expire, renewable requirements increase and coal resources are phased out, PGE's will need to add resources to maintain reliability.

### **Adding annual dispatchable resources — 375-550 MW**

With increasing reliance on renewable generation, PGE faces potential challenges in maintaining enough flexibility to adequately balance renewables and meet customer energy demands in the future. A thorough comparison of the performance of various flexible technology options is presented in Section 5.3, Flexible Capacity. PGE proposes pursuing acquisition of 375 to 550 MW of long-term annual dispatchable resources.

### **Adding annual or seasonal capacity resources — up to 400 MW**

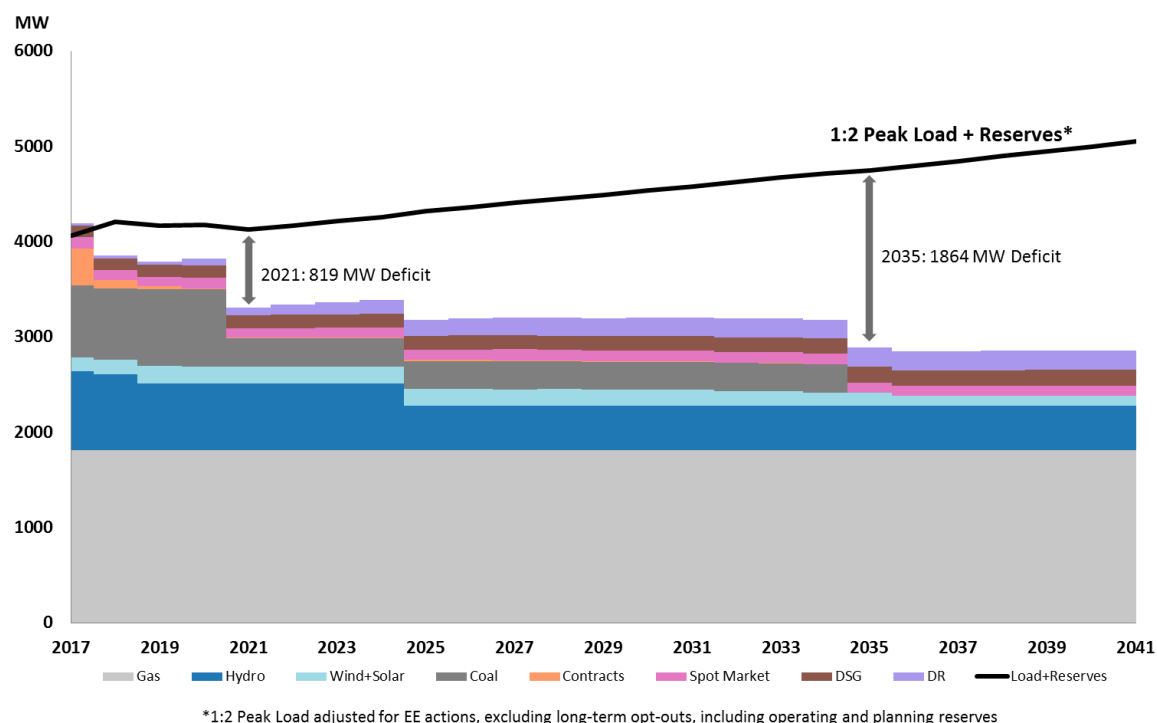
Achieving high standards for providing reliable service to customers and meeting regional reliability requirements are critical priorities for PGE. PGE will consider a mix of annual and seasonal resources to fill the remaining capacity need.



In 2021, after Boardman ceases coal-fired operations, PGE's capacity deficit is 819 MW. Figure 1-1 provides a summary of the capacity deficit from 2017 through 2041.

The capacity adequacy study is discussed in Section 5.1, Capacity Adequacy and Capacity Contribution.

**FIGURE ES-2: PGE's estimated annual capacity need**



## Scenario Analysis

### Methodology

PGE designed 23 portfolios to consider various resource strategy questions (e.g., RPS compliance timing) and to identify a Preferred Portfolio. PGE then evaluated the total cost of meeting customer demand with each portfolio under reference case assumptions, yielding the primary cost metric used throughout the IRP. To evaluate the price risks to customers, PGE also designed 23 potential future environments in which key variables deviate from their reference forecasts. These key variables include fuel prices, carbon prices, load growth, capital costs, hydro availability, and renewable resource performance. Risk metrics were designed to characterize variability (how much the cost may swing due to uncertain conditions), severity (how high costs may rise under worst case assumptions), and durability (how consistently well or poorly a portfolio performs relative to the other portfolios across the futures). These metrics are described in Chapter 11, Scoring Metrics.

## Guiding Principles

To meet future resource needs, PGE designed candidate resource portfolios and developed a methodology for evaluating these portfolios with four factors in mind: Policy, Reliability, Technology, and Price.

**Policy** — PGE designed all portfolios to comply with existing state and federal regulations, including the Clean Power Plan (CPP) and SB 1547. In addition, portfolio evaluation incorporated the impact of renewable policies in other states on the performance of PGE’s resources and the projected impact of the CPP on carbon prices. See Chapter 3, Planning Environment, for more information.

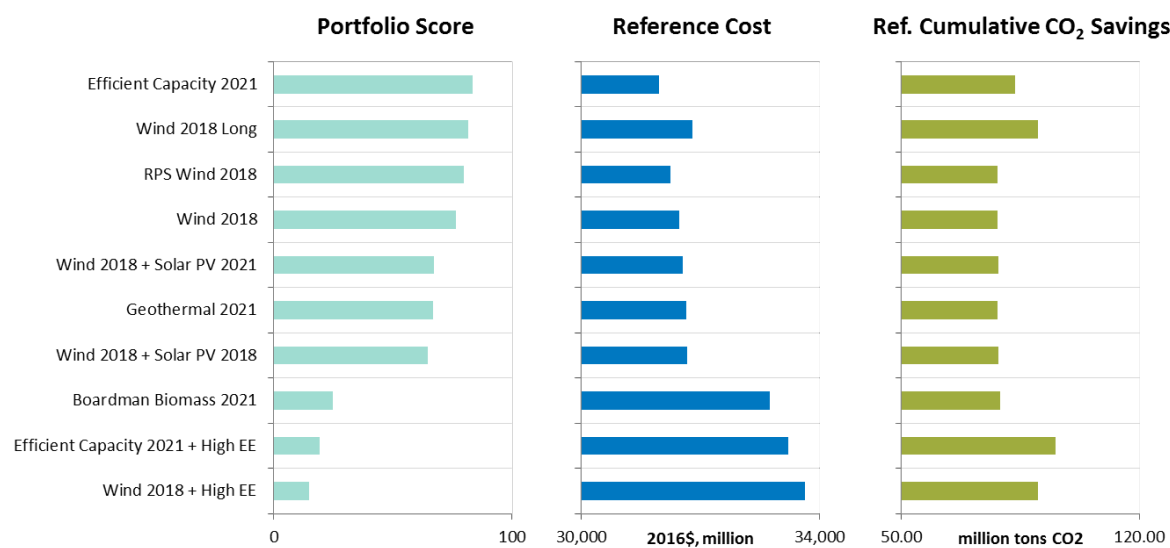
**Reliability** — PGE designed portfolios to meet a reliability target that ensures a loss of load probability not exceeding one day in 10 years and to meet a flexibility requirement of approximately 400 MW of dispatchable resources to accommodate the variability and uncertainty of renewable resources on the system. Reliability requirements are discussed in Chapter 5, Resource Adequacy.

**Technology** — PGE included a diverse set of technologies in portfolio analysis, including demand-side resources like energy efficiency, demand response, dispatchable standby generation, and supply-side resources like large-scale wind, solar, biomass, geothermal, and natural gas. These resources are discussed in Chapter 6, Demand Options, and Chapter 7, Supply Options. In addition, PGE undertook more detailed studies of emerging technology potential and value, including energy storage and demand response, to inform both the current and future IRPs. These studies can be found in Chapter 6, Demand Options, Chapter 8, Energy Storage, and Appendix I, Demand Response Programs, respectively.

**Price** — PGE’s evaluation prioritized the need to meet customer’s demands at low cost and low risk should future conditions evolve differently than currently anticipated. This least-cost, least-risk framework is the foundation of the portfolio evaluation methodology, and is discussed further in Chapter 10, Modeling Methodology.

## Key Findings

1. All actionable portfolios incorporate the same levels of demand response, conservation voltage reduction, and dispatchable standby generation and include, at a minimum, all cost-effective energy efficiency identified by the Energy Trust.
2. Acquiring a greater quantity resources that qualify for the Production Tax Credit reduces costs to customers, and capturing more of the PTC, by acquiring physical resources earlier, is more affordable than deferring an RPS build to 2025.
3. All actionable portfolios include procurement of flexible resources to meet the capacity need that remains after accounting for the capacity contributions of the renewable, conventional, and energy efficiency resources incorporated into each portfolio.
4. Portfolios that include cost-effective EE and renewable resources to meet RPS requirements, along with highly efficient flexible generation, perform relatively better than other candidate portfolios, as shown in the chart below.

**FIGURE ES-3: Performance of actionable portfolios**

## Recommended Action Plan

The Preferred Portfolio forms the basis for the recommendations put forward in the Action Plan. The Company's analysis has led to the development of a plan that consists of diverse resources which, when integrated with PGE's existing portfolio, offer a balance of cost and risk and a strategy for PGE to reliably and adequately serve customers into the future while meeting our sustainability goals.

Consistent with the Commission's IRP Guidelines, PGE plans to undertake the major activities of resource procurement in the next two to four years, or by 2020. In addition, planning considerations beyond 2020 also inform the Action Plan, such as the Oregon law requiring 50% renewables by 2040.

The Action Plan allows PGE to effectively respond to continued load growth, increasing system variability, and existing resource expirations. The Company will complete its resource acquisitions through a combination of actions related to both existing and new resources. The Action Plan spans diverse technologies in three categories of resource actions: demand-side, supply-side, and integration.

More specifically, demand-side actions include continuing the support of cost-effective energy efficiency and pursuing Demand Response and Conservation Voltage Reduction programs. Supply-side actions include RPS compliant renewable resources, capacity resources (both annual and seasonal) and Dispatchable Standby Generation. In addition, PGE will attempt to renew expiring hydro contracts and plans to submit a proposal for the development of energy storage systems. To inform the next IRP or IRP Update, PGE also suggests Enabling Studies in the Action Plan. The key elements of the Action Plan are discussed in the following sections.

## Demand-side Actions

### Energy Efficiency

PGE supports deployment of cost-effective energy efficiency by the Energy Trust of Oregon (Energy Trust) targeting the addition of 135 MWa (176 MW<sup>2</sup>) from 2017 through 2020.

### Demand Response

PGE will pursue the acquisition of Demand Response (DR) targeting the capacity addition of 77 MW (winter) and 69 MW (summer) through 2020.

### Conservation Voltage Reduction

PGE will pursue programmatic Conservation Voltage Reduction (CVR) deployment, targeting minimum energy savings of 1 MWa through 2020. To enable that conversion, PGE is pursuing smart meter voltage data bandwidth expansion and data analytics research and development efforts to support system-wide expansion of a dynamic CVR program.

## Supply-side Actions

### Renewable Resources

PGE intends to issue one or more Requests for Proposals (RFPs) for approximately 175 MWa (equivalent to 515 MW nameplate of wind generation) of bundled RPS-compliant renewable resources (energy and RECs), and/or Renewable Energy Certificates (RECs), with a preference for maximizing available federal incentives (such as sec 45 Production Tax Credit) for the benefit of customers.

### Standby Resources

PGE will pursue expansion of Dispatchable Standby Generation (DSG) by 16 MW to meet standby capacity needs (non-spin). PGE will also pursue actions (such as customer site development and contract negotiation) to achieve additional annual standby targets, if needed beyond 2020.

### Hydro Contract Renewals

PGE will pursue the renewal, or partial renewal, of expiring hydro contracts, and if cost-effective contract terms are available, acquire them for customers.

### Energy Resources

PGE will assess the energy value brought by RPS or capacity resources through the RFP process and capture the merits of high capacity factor resources through reduced exposure to the market.

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<sup>2</sup> Gross value at busbar.

## Capacity Resources

PGE's capacity need in 2021, after actions for EE, DR, CVR and DSG, and accounting for imports and executed Qualifying Facility (QF) contracts<sup>3</sup> that are not yet online, is approximately 819 MW.<sup>4</sup>

PGE will issue one or more RFPs to acquire up to 850 MW of capacity that could be a mix of annual and seasonal resources. PGE may also enter into short and/or mid-term contracts (e.g., 2-5 years) to maintain resource adequacy between the time the capacity is needed and the time in which resources can be acquired through an RFP. Of the up to 850 MW, and in alignment with the Preferred Portfolio, PGE proposes pursuing acquisition of 375 to 550 MW of long-term annual dispatchable resources and up to 400 MW<sup>5</sup> of term-limited annual (or seasonal equivalent) capacity resources.

## Integration Actions

### Energy Storage

Pursuant to House Bill (HB) 2193, and not later than January 1, 2018, PGE will submit one or more proposals to the Commission for developing a project that includes one or more energy storage systems that have the capacity to store at least 5 megawatt hours of energy.

## Enabling Studies

Enabling studies provide useful research actions to inform the next IRP. PGE proposes several enabling studies to evaluate:

- The treatment of market capacity
- Continued flexibility and curtailment metrics
- Customer insights
- Others as identified.

PGE will work with stakeholders to develop appropriate scopes of study for these enabling studies.

## Conclusion

For decades, American electric utilities have provided the energy systems and infrastructure that underpin the nation's economy. PGE has been part of that history since the Company began serving customers in 1889 with the first long-distance transmission line in the country. This 12-mile line – a connection from Willamette Falls to downtown Portland – started the one-way streamflow of electricity on the Company's system to the customer. Accordingly, PGE evaluated resources in a linear fashion, individually considering generation, transmission, and distribution.

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<sup>3</sup> Some Qualifying Facilities are in early stage development and are at increased risk for delay or cancellation. PGE's capacity need will be greater if QF's under contract fail to come on line as planned.

<sup>4</sup> Annual capacity value.

<sup>5</sup> Quantity subject to change based on incremental acquisitions: renewable acquisitions, contract execution, etc. Seasonal capacity products have capacity contribution values of less than 100%. For example, a contract for 300 MW of summer and winter capacity (July-September, December-February, On-peak hours) is equivalent to approximately 240 MW of an annual resource. See Chapter 5, Resource Adequacy for additional discussion.



Since energizing that first major innovation, PGE has continuously made advances that influence the generation, transmission, and consumption of power in Oregon and the region.

Today, PGE's commitment to innovation continues as the Company incorporates current technological development with the evolution of the integrated grid in resource planning.

PGE is committed to serving our customers and being their trusted energy partner. The 2016 IRP delivers on that commitment by offering detailed technical analyses of the options for supplying the electric power our customers need. This IRP represents a continuous evolution of PGE's IRP process, which incorporates changes in local, regional, and national planning environments, and adapts to shifts in Oregon's energy future. Comprehensive scenario analysis captures the effects of various potential future states of the world. Combining information from the analysis with the broad experience and expertise of PGE and stakeholders, the Action Plan balances cost and risk measures, and takes full advantage of technologies and markets to enable a smarter, greener, more flexible generating portfolio and distribution system.





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