Integrated Resource Plan

JULY 2019

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Contents

Figures

Tables

Portland General Electric's 2019 Integrated Resource Plan embraces the positive change that is shaping our industry, while prioritizing universal access to clean, affordable and reliable electricity.

This is the first plan developed since we made our commitment to cut PGE's greenhouse gas emissions by more than 80% by 2050. It proposes measured steps we can take today to address the climate crisis, while allowing flexibility for adjustments as technology and policies continue to evolve.

This document underscores our commitment to transparency and collaboration. We engaged customers and stakeholders throughout its development, and their insights and feedback were instrumental in shaping our resource strategies.

This IRP also embodies the spirit outlined in our "**Vision for a Clean Energy Future**." Since we introduced our vision in 2018, we have been accelerating the transformation of our company:

- We announced the Wheatridge Renewable Energy Facility, the first of its scale to combine wind and solar energy with battery storage.
- The Boardman plant will cease coal-fired operations at the end of 2020.
- We are working to advance electrification in other areas of the economy, especially the transportation system, which accounts for 40% of Oregon's GHG emissions.
- We are enhancing reliability by modernizing our systems to create a smarter, more resilient grid.

Our 2019 IRP is the culmination of a multi-year research and engagement process — our most exhaustive analysis ever. After constructing and testing 43 different portfolios, we identified actions needed between now and 2025 to move us forward on our path to our 2050 goal. The plan calls for:

- 150 MWa of renewable resources by 2023.

- A similar amount (157 MWa) of cost-effective energy efficiency.
- Increased reliance on demand response to help balance sources and uses of electricity during peak months. This includes 141 MW during winter months, 211 MW during summer months and 4 MW of customer battery storage.
- Additional actions to help meet capacity needs as a result of expiring contracts and the retirement of baseload coal plants like Boardman.

The energy industry is undergoing a period of profound change and uncertainty driven by climate change, new technologies and changing customer expectations. By incorporating maximum flexibility into the plan, we will be able to accommodate shifts in needs, in consultation with the Oregon Public Utility Commission and our stakeholders.

We believe our 2019 IRP represents the very best path forward and welcome feedback from our customers and stakeholders during the coming review process. Combatting the climate crisis while ensuring universal access to reliable, affordable electricity demands leadership, vision and commitment.

It's a call for all of us to work together for a clean energy future for Oregon.

Sincerely,

Maria Pope | President and CEO

Executive Summary

Portland General Electric (PGE, or the Company) is proud to submit our 2019 Integrated Resource Plan (IRP) for consideration by our customers, stakeholders, and the Public Utility Commission of Oregon (OPUC, or the Commission). In 2018, we made a simple but daunting commitment to lead the transformation to a clean energy future for our customers and our corner of the Pacific Northwest. We made that commitment to lead because we believe combatting climate change while ensuring universal access to reliable and affordable electricity is a societal imperative, and that it will not happen without leadership, vision, and commitment. We also have an obligation to ensure that the electric system transformation does not leave anyone behind, with all customers sharing in the benefits and opportunities of a clean energy future. Our 2019 Integrated Resource Plan is our first long-term plan since making that commitment, and it incorporates this vision for our clean energy future. It shows a pathway to reach our long-term goals given what we know today, and acknowledges the vast uncertainty that faces our industry in the coming decades. We propose measured near-term actions to set us in the right direction while ensuring that we can continue to deliver affordable and reliable electricity. Our plan focuses on three major steps to meet commitments to customers in service of our shared clean energy future.

1. Engage our customers around new technologies and programs.

Our plan asks that everyone play their part in creating a clean energy future. To help us, we will ask our customers to engage with us in new ways.

Energy efficiency. PGE has long used energy efficiency (EE) to deliver low-cost and low-carbon results for our customers. We estimate that, with the help of our customers, we currently avoid about one million metric tons of greenhouse gas emissions ($MMtCO_2e$) per year with energy efficiency investments made since 2010. That's equivalent to taking about 150,000 cars off the road or about 17 percent of our annual greenhouse gas (GHG) emissions. Our plan calls for continued investments in cost-effective energy efficiency, which we estimate could avoid an additional 0.7 $MMtCO_2e$ per year by 2025.

Distributed flexibility. With distributed flexibility, we can use the technologies and energy behaviors of our customers (in their home or business) to provide the same services and value that power plants and grid investments provide. This includes demand response programs, such as installing smart thermostats and smart electric vehicle (EV) chargers, as well as programs that allow customers to help support the grid with their backup power and battery storage systems. Under our plan we estimate that by 2025 our distributed flexibility programs will avoid the need for approximately 200 MW of conventional generation, about half the size of the Carty Generating Station. And we expect these programs to continue to grow as more of our customers adopt new clean technologies, like EVs, over time.

These distributed energy resource (DER) programs are critical to our ability both to drive carbon out of our economy and to maintain reliability in the electricity system at a low cost.

2. Decarbonize our energy supply as cost effectively as possible.

To reach our long-term decarbonization goal, we will need additional renewable resources, like wind and solar, to drive greenhouse gases out of our generation portfolio. Specifically, we estimate that we will need to add at least 50-60 MWa[1] of new renewables every year for the next thirty years. To make meaningful progress while taking advantage of continued cost declines and the limited remaining availability of federal tax credits, our plan calls for additional renewables in the near term. These renewables will expand our renewable portfolio and complement the voluntary options, like our Green Tariff, that allow customers who so choose to decarbonize even faster.

Renewable procurement. Our plan calls for an additional 150 MWa of new renewable resources by 2023, with conditions that will ensure low-cost outcomes for our customers. We estimate these renewables will save about 0.6 $MMtCO_2$ per year through 2050. Our near-term plan will help us make real progress toward our goal while maintaining flexibility to respond as conditions change in the future.

3. Maintain reliability by leveraging what we have today and embracing new clean technologies.

Our plan identifies the potential need for significant amounts of additional resources to maintain reliability in the mid-2020s, due in part to the loss of about 350 MW of capacity as contracts that we've signed for resources in the region expire. During this same time, we expect the Pacific Northwest region to require additional resources due to retiring coal plants. Forecasts also show that the costs of new clean technologies, like energy storage, will continue to decline. We propose a staged process to allow us to take measured actions that support reliability in the face of continued uncertainty.

Pursue cost-competitive existing resources. To continue to drive down both carbon and costs, it is essential that we make the best use of resources that are already available in the region. Our first step to ensuring reliability is to seek agreements for capacity on existing resources in the region to the extent that they are available and cost-competitive.

Clean technology procurement. If, despite our other actions, we still forecast a potential reliability shortage in the mid-2020s, we plan to conduct a competitive solicitation for new non-emitting resources that support reliability. This could include battery storage, pumped hydro, renewable resources, or combinations of renewables and storage. The solicitation would exclude new fossil fuel-based generation.

When taken together, we believe these actions will allow us to meet our customers' needs while maintaining affordability in a way that is consistent with our values and the values expressed within the public process that supported the development of this plan.

The following sections briefly summarize the observations, assumptions, and analysis that underpin our plan.

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[1] An average MW (or MWa) is shorthand for the amount of energy that a resource produces on average over the course of a typical year. Because renewables and many power plants do not produce energy all of the time, they typically produce fewer MWa than their total generating capacity.

ES.1 A Changing Energy Landscape

The 2019 IRP was developed against a landscape of rapid growth in clean energy. Our customers, and electricity customers across the country, want clean energy and expect us to act to help avert the climate crisis. Policymakers in Oregon and around the West have responded with new state policy proposals that support decarbonization through both economic signals and clean energy mandates. Many states in the West have adopted aggressive new clean energy policies that further the expansion of renewable resource development and the retirement of emitting thermal resources, including California, Washington, New Mexico, Nevada, and Colorado. In Oregon, the legislature contemplated House Bill (HB) 2020, which would have authorized a cap and trade program—called the "Oregon Climate Action Program"—starting January 1, 2021. HB 2020 would have helped facilitate decarbonization of our energy supply and accelerated transportation electrification, and would have protected our customers from unnecessary price impacts while doing so. PGE joined environmental and consumer advocates, organized labor, businesses, family forestland owners, rural economic development organizations, and other utilities in supporting passage of HB 2020. Although this bill did not pass during the 2019 legislative session, PGE is committed to reducing our greenhouse gas emissions by more than 80 percent by 2050, consistent with our proportionate share of the state's economy-wide GHG reduction goal, and will continue to engage in and advocate for policies that are consistent with our strategy while protecting affordability and reliability.

Amidst broad consumer- and policy-driven change, clean energy technology companies are rising to the challenge. As a result, cost declines for wind, solar, and battery technologies continue, and clean technologies are increasingly competitive with conventional fossil fuel-based generators. The make-up of the grid has shifted quickly and wholesale electricity markets in the West are increasingly experiencing the availability of zero or negative marginal-cost renewable power. Simultaneously, the retirement of thermal generators has accelerated the potential for capacity shortages in the West and reinforced the need for both sound utility planning and regional solutions.

ES.2 Our Planning Process

Integrated resource planning provides a thoughtful way for PGE and the region to pursue and embrace the positive change that our industry is undergoing, while ensuring that our customers have access to affordable and reliable energy. The process allows us to align the way we do business with our customers' values, as well as local and state energy policies. To engage the public in the development of our plan, we host a public process in which we provide information and request feedback to help guide our decision-making.

Before we began work on the 2019 IRP, we engaged stakeholders in a conversation around guiding values. We heard that affordability, sustainability, and transparency were paramount to many of our stakeholders as they engaged in the IRP process. We kept these values in mind throughout our planning and took tangible steps to be responsive to what we heard. Specifically, we shared draft analyses more frequently, requested feedback on specific design questions, invited stakeholders to submit informal comments throughout the process, and modeled specific portfolios requested by stakeholders.

Over the 17-month public process for the development of the 2019 IRP, we held 12 public meetings, which were attended by 221 people online and in person. We received 58 written comments, five portfolio requests, and hosted our first community listening session to seek feedback from traditionally underrepresented groups that work within the communities we serve. We are grateful to everyone who chose to participate in our public process and hope those who participated will see their vital feedback reflected in our plan. While we received generally positive feedback about our efforts to engage stakeholders that traditionally participate in our process, we were much less successful in bringing new perspectives into our process. This will be an area of continued focus for PGE as we work to engage the communities we serve in our planning and decision-making processes.

To address both the evolving energy landscape and the feedback that we heard throughout our process, we designed and implemented the 2019 IRP with a focus on four key themes: decarbonization; customer decisions; uncertainty and optionality; and technology integration and flexibility. These themes encompass some of the most pressing questions facing our industry today and in the coming decades.

- **Decarbonization.** We are committed to enabling local transformation to a clean energy economy. By 2050, we will reduce our greenhouse gas (GHG) emissions by more than 80 percent and help decarbonize other sectors in the economy by enabling the adoption of new clean electric technologies, like EVs. To support these goals, we considered decarbonization and the clean energy transition through several new innovative analyses within the IRP, including our Decarbonization Study[2] and related Decarbonization Scenario,[3] carbon pricing reflective of a potential cap and trade program in Oregon,[4] a scoring metric reflecting portfolio performance in a carbon-constrained future,[5] and incorporation of market-based EV forecasts throughout our analysis.[6] These components of our plan help to ensure that PGE will continue to drive GHGs out of our energy economy and that we will be well positioned to serve our customers in a clean energy future.
- **Customer decisions.** Increasingly, customer decisions around their energy use and the source of their energy are impacting the electricity sector, including long-term planning. In the 2019 IRP, we address customer decisions through a comprehensive study (the Navigant "DER Study") of customer adoption of DERs and customer participation in distributed flexibility programs (including demand response and dispatchable customer storage).[7] We also tested sensitivities related to customer participation in voluntary renewable programs.[8] Our goal in these exercises is to ensure that our plans are robust across a range of potential customer

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[2] The Decarbonization Study can be found in External Study 1. Deep Decarbonization Study.

[3] See Section 1 Decarbonization Scenario.

[4] See Section 1 Carbon Prices.

[5] See Section 1 Scoring Metrics.

[6] See Section 1 Electric Vehicles.

[7] Information from the DER Study is referenced in Chapter 1. Resource Needs and Chapter 1. Resource Options. The study can be found in External Study 1. Distributed Energy Resource Study.

[8] See Section 1 Voluntary Renewable Program Sensitivities.

decisions in the future and to ensure that utility actions and customer actions remain compatible and coordinated.

- **Uncertainty & optionality.** We anticipate the current rapid change in technology, policy, and wholesale markets is likely to continue in the foreseeable future. As such, our 2019 IRP provides a robust treatment of uncertainty in terms of both the range of potential futures considered and the incorporation of these futures into portfolio analysis. We consider 810 potential futures that depend on economic conditions, technological progress, natural gas prices, carbon prices, hydro conditions, and the future deployment of renewables across the West. In response to our stakeholders, we have also evolved our portfolio construction and scoring process to better reflect the value of optionality amidst these uncertainties and to better capture the risks associated with commitments to new large and long-lived energy infrastructure.
- **Technology integration and flexibility.** With the continued proliferation of renewable and distributed resources, it is increasingly important that our planning consider the challenges and opportunities associated with integrating these technologies. Building on PGE's leadership in renewable integration and energy storage analysis, the 2019 IRP incorporates a holistic evaluation of flexibility challenges and potential solutions through three related exercises: an integration cost study for renewables,[9] a flexibility value analysis for dispatchable resources,[10] and a flexibility adequacy study for our portfolio.[11] In anticipation of future distribution resource planning (DRP) efforts, we also provide an example of how locational value may factor into resource economic evaluation in future IRPs.[12]

ES.3 Growing Resource Needs

Our analysis to support the 2019 IRP begins with a detailed evaluation of our need for resources. PGE meets customer needs with a diverse portfolio of resources, including energy efficiency, renewables, hydropower, and thermal generation. Over time, our resource needs shift due to changes in demand, changes in our resource mix (due to retirements or expiring contracts), and policy drivers, like the Renewable Portfolio Standard (RPS).

Our analysis shows that PGE faces growing resource needs and uncertainty throughout the 2020s. As approximately 350 MW of capacity contracts expire in the mid-2020s, we face increasing needs for resources that support reliability (i.e., capacity needs), even after considering the potential impacts of distributed energy resources like energy efficiency, customer-sited solar and storage, and demand response. Under Reference Case assumptions, these capacity needs grow to 685 MW by 2025. However, uncertainties in economic conditions, DER adoption, EV adoption, and market availability suggest that our needs in 2025 could range between approximately 350 MW and approximately 1,000 MW. These estimates exclude the potential impacts to regional reliability of loads that elect to take energy service from an energy service supplier (ESS) through long-term direct access (LTDA) or

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[9] See Section 1 Integration Costs.

[10] See Section 1 Flexibility Value.

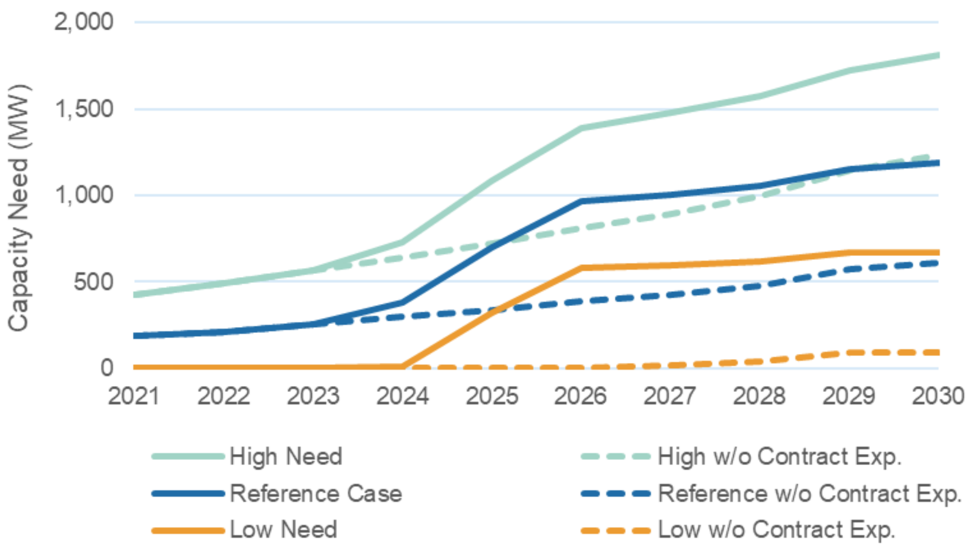
[11] See Section 1 Flexibility Adequacy.

[12] See Section 1 Locational Value.

New Load Direct Access (NLDA). In Docket No. UE 358, PGE urges the OPUC to allow PGE to plan for the capacity needs associated with these loads so that we can effectuate our role as their reliability provider as the region becomes more capacity-constrained.

Our need for new dispatchable capacity resources in the mid-2020s will depend strongly on our ability to replace expiring contracts with similar quantities of capacity. As shown in Figure ES-1 below, if we replace all expiring contracts with new contracts, on a 1-for-1 capacity basis, and our needs grow relatively slowly (as indicated by the Low Need Future), we may be capacity-adequate without new resource additions. However, if cost-competitive capacity options are not available in the market and we face more quickly growing needs (as indicated by the High Need Future), over 1,000 MW of new capacity resources may be required by 2025. The possibility of these two widely divergent scenarios requires our Action Plan to be both flexible enough for us to respond to evolving conditions and robust enough to provide for significant procurement of new resources should the identified needs persist.

FIGURE ES-1: Future capacity needs under various scenarios



Our analysis also suggests that without incremental action, our generation portfolio is expected to be short to the market on an average annual basis beginning in 2021, with the forecast market shortage generally growing into the future. By 2025, the market shortage exceeds 344 MWa in 90 percent of futures and is forecast to be 515 MWa in the Reference Case. Consistent with this finding and the potential for voluntary programs to provide incremental energy to the portfolio, we considered only those portfolios that add less than 250 MWa in incremental resources through 2025 in selecting our preferred portfolio.

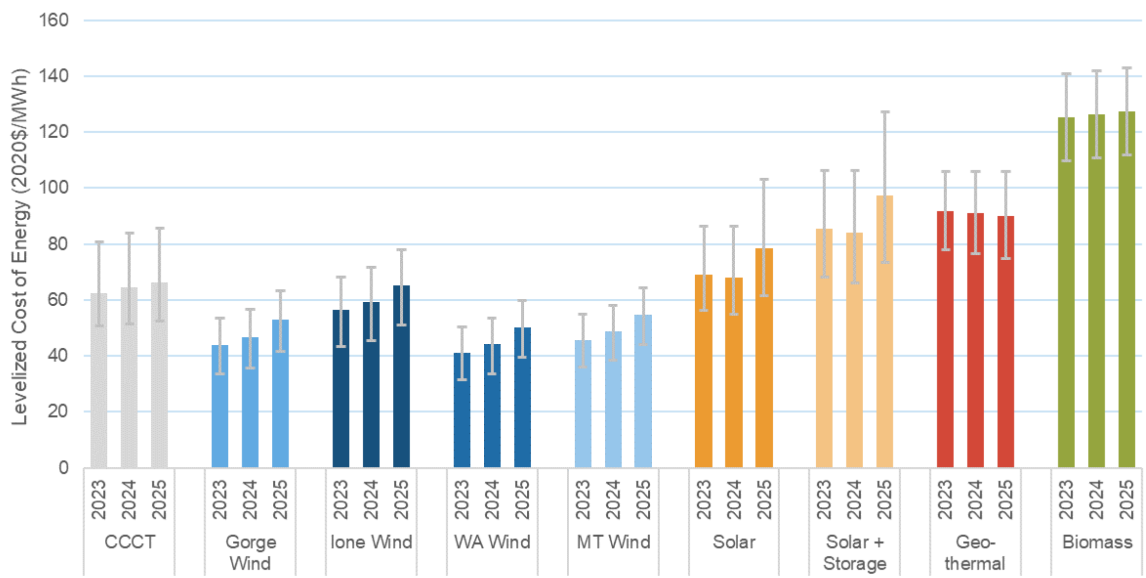
Our analysis did not identify near-term needs for additional Renewable Energy Credits (RECs) to meet Renewable Portfolio Standard (RPS) obligations. Our forecasts indicate that we expect to be physically compliant with the RPS through 2029 and that banked RECs could be used to defer the need for incremental RECs until 2036. However, deferring action would preclude the opportunity to secure low-cost resources to meet near-term capacity and energy needs with clean technologies. It would also create an impractical requirement that we successfully procure 627 MWa of additional renewables over two years to comply with the RPS in 2037. We do not believe that our near-term renewable strategy should rely on such an unrealistic assumption about future procurement.

The energy and capacity needs we identified in the mid-2020s can be met in a variety of ways. For example, we can meet energy needs through a combination of purchases from wholesale energy markets and new energy resources, like wind and solar. Similarly, we can meet capacity needs through a combination of renewable resources, dispatchable capacity resources (such as thermal generators and energy storage), or contracts with other entities in the region. More information about the resource options considered in the 2019 IRP can be found in Chapter 1. The remainder of the IRP focuses on the tradeoffs between these resource options and the identification of the best combination of resource options for PGE to pursue to meet our customers' needs.

ES.4 Shifting Resource Economics

One of the primary changes influencing the electricity sector and resource planning is the continued cost decline of clean technologies like wind, solar, and battery energy storage. The combination of cost declines and the continued availability of federal tax credits in the near-term create a time-limited opportunity to secure cost-competitive clean resources to meet our customers' needs. Figure ES-2 shows the real-levelized cost of each of the generic energy resource options considered in our 2019 IRP.

FIGURE ES-2: Levelized costs of energy resource options by type and online date

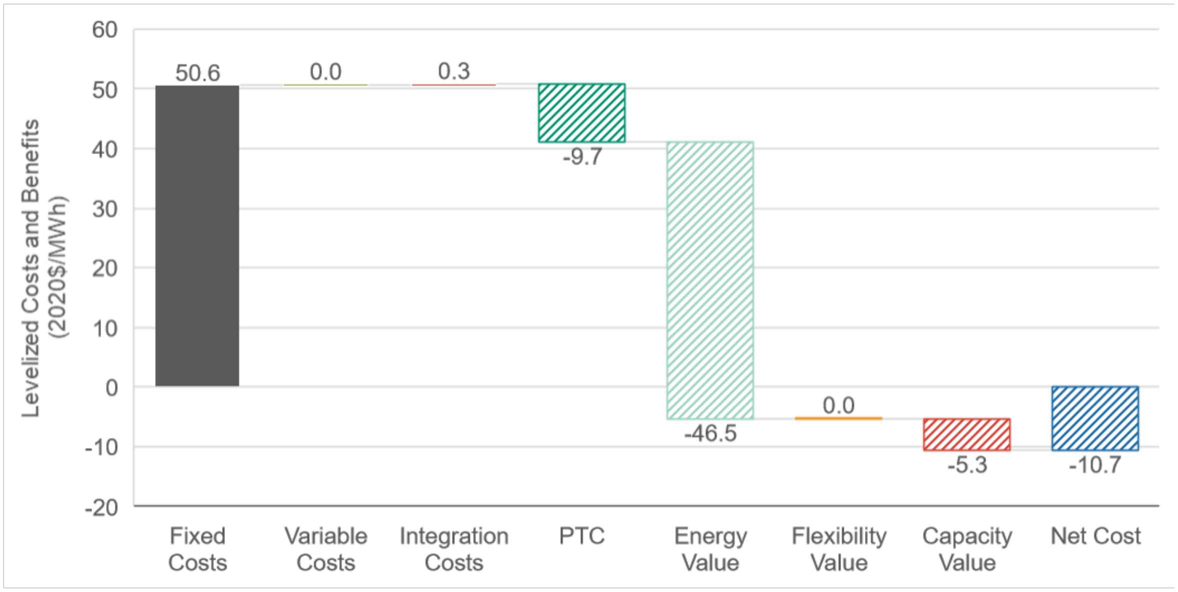


Our analysis suggests that wind resources may provide the lowest-cost energy compared to other energy resources, including combined-cycle combustion turbines (CCCTs). It also indicates that cost uncertainty is relatively large compared to the cost differences between energy resource options. This highlights the importance of taking incremental actions to procure renewable resources, while preserving optionality with respect to technology, resource type, and location in competitive solicitations.

The levelized costs also highlight the benefits of near-term renewable action to qualify for federal tax credits. Wind projects that come online by December 31, 2022[13] may qualify for the federal production tax credit (PTC) at the 60 percent level. The PTC steps down to the 40 percent level for projects that come online the following year and then goes away. At the 60 percent level, we find that the PTC lowers the cost of wind by approximately 20 percent, providing an incentive of about $170 million to pursue 150 MWa of wind in the near-term, rather than waiting until 2025 or later. The federal investment tax credit (ITC) provides a similar incentive for solar. The ITC scales down from 30 percent to 10 percent for projects that come online after December 31, 2023.[14] We estimate that the availability of the 30 percent ITC reduces the cost of solar and solar plus storage by approximately 16 percent relative to the 10 percent ITC, providing an additional incentive to acquire renewable resources prior to 2025.

In addition to cost, we analyzed the various benefits that renewable resources bring to the system and compared them to alternative ways of meeting customer needs. We found that by helping to meet both our energy and capacity needs, wind resources are expected to bring more benefits than costs over their lifetime (see Figure ES-3). In the Reference Case, a 150 MWa Washington Wind resource that qualifies for the 60 percent PTC saves about $180 million over its lifetime relative to a strategy of relying on the market for energy and a simple-cycle combustion turbine for an equivalent amount of capacity.

FIGURE ES-3: Costs and benefits of Washington Wind resource that comes online by December 31, 2022



While the long-term benefits of pursuing near-term renewables are compelling, our stakeholders have raised questions about whether today's customers should be paying for resources that will benefit customers in future years. To address this question of intergenerational equity, we estimated

[13] Our analysis considers such a project to have a 2023 online date.

[14] These projects come online in 2025 in our analysis because we assume that projects that would come online in 2024 would be accelerated to December 31, 2023 to qualify for the higher level of tax incentive.

the potential average impact to retail power prices of pursuing renewables within the 2019 IRP Action Plan between 2021 and 2035. Our analysis found that pursuing near-term wind is expected to cause a small net increase in power prices between 2023 and 2026 (approximately 0.04 cents per kWh[15]) but is expected to result in lower power prices beginning in 2027 or 2028, relative to a strategy of meeting customer energy and capacity needs without the renewable addition. Waiting until 2026 for the same wind addition would result in larger estimated power price impacts due to the unavailability of federal tax credits (approximately 0.05 cents per kWh between 2026 and 2030) and would not result in net reductions to power prices until 2031. While we found that near-term renewable action does bring forward some costs and the associated potential for small increases in power prices, the benefits of securing federal tax credits also reduce the expected magnitude of near-term power price increases and brings forward the potential for power price reductions associated with renewables from the early 2030s to the late 2020s. The exact impacts to rates and timing of these impacts will depend on the cost and performance of acquired resources and future market conditions.

Technological innovation has also led to dramatically reduced costs for battery storage in recent years, challenging the notion that meeting capacity needs will necessarily require new fossil fuel-based resources. Our analysis suggests that by 2025, battery resources may be cost-competitive with a simple-cycle combustion turbine (SCCT). The 2019 IRP made significant progress toward better understanding the potential role of battery storage within our portfolio, particularly with the analysis of storage capacity contribution and flexibility value. However, we have identified energy storage as a critical area for additional learning. Future efforts will focus on quantification of locational value of battery storage through PGE's distribution resource planning (DRP) process, and continued refinements in energy storage methodologies in the IRP.

ES.5 Portfolio Analysis – Bringing it All Together

We constructed 43 portfolios of resource options that tested a wide range of potential strategies for meeting our near-term needs. Some portfolios tested specific resource options in isolation or tested variations in the size and timing of resource actions, while others utilized optimization algorithms to design portfolios to meet objectives of interest to PGE and/or our stakeholders. Figure ES-4 summarizes the resulting resource additions through 2025.

To compare the portfolios, we evaluated each across a set of non-traditional scoring metrics as well as traditional cost and economic risk metrics. We selected the non-traditional scoring metrics based on feedback received in our public process and to account for risks not captured with the traditional economic risk metrics. We excluded portfolios that performed among the worst with respect to any non-traditional metric from further evaluation. We then identified the best performing portfolios based on their performance with respect to the traditional cost and economic risk metrics. The near-term resource additions in these portfolios are shown in Figure ES-5.

15 For reference, total revenues per kWh as reported in the FERC Form 1 for 2018 were approximately 10.2 cents/kWh.

FIGURE ES-4: Resource additions through 2025 across the portfolios investigated

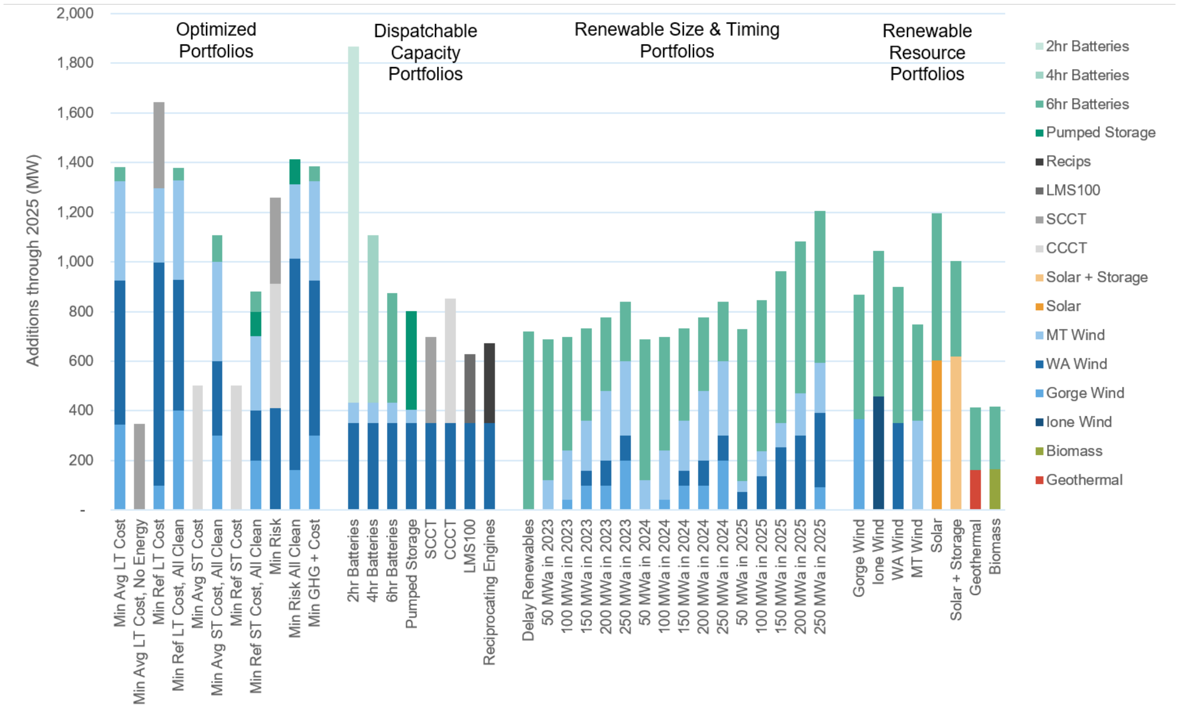


FIGURE ES-5: Resource additions in best performing portfolios

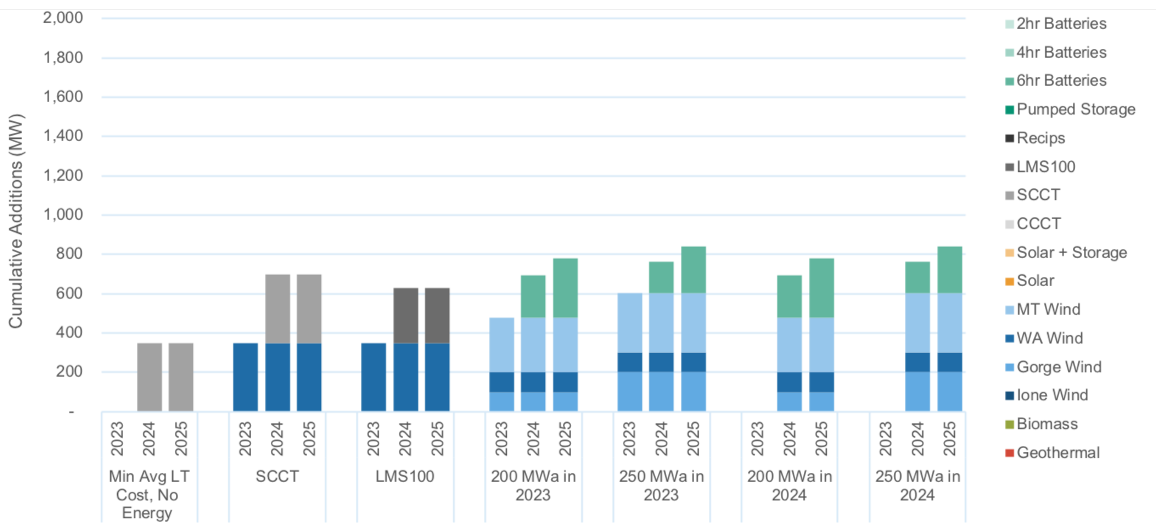


Table ES-1 and Table ES-2 list the traditional and non-traditional scores for each of the best performing portfolios.

TABLE ES-1: Portfolio scores for best performing portfolios, traditional scoring metrics

Portfolio	Category	Cost	Variability	Severity
Min Avg LT Cost, No Energy	Optimized	25,436	3,808	30,987
SCCT	Dispatchable Capacity	25,351	3,675	30,699
LMS100	Dispatchable Capacity	25,515	3,652	30,863
200 MWa in 2023	Renewable Size & Timing	25,744	3,653	30,987
250 MWa in 2023	Renewable Size & Timing	25,620	3,605	30,807
200 MWa in 2024	Renewable Size & Timing	25,804	3,648	31,043
250 MWa in 2024	Renewable Size & Timing	25,693	3,611	30,879

TABLE ES-2: Portfolio scores for best performing portfolios, non-traditional scoring metrics

Portfolio	GHG-Constrainted Cost	Near Term Cost	High Tech Future Cost	GHG Emissions	Incremental Criteria Pollutants	2025 Energy Additions
Min Avg LT Cost, No Energy	25,351	6,025	15,313	108	61	10
SCCT	25,266	6,051	15,256	102	61	160
LMS100	25,430	6,067	15,418	102	265	189
200 MWa in 2023	25,713	6,099	14,919	100	0	183
250 MWa in 2023	25,577	6,097	15,009	97	0	236
200 MWa in 2024	25,773	6,093	14,977	101	0	183
250 MWa in 2024	25,650	6,089	15,080	98	0	236

The best performing portfolios share the following commonalities:

- **Customer resources:** All portfolios include all cost-effective energy efficiency and DER adoption and participation assumptions based on the Navigant DER Study.
- **Renewable resource additions:** Six of the seven best performing portfolios incorporate renewable actions prior to 2025 (four add renewables in 2023 and two add renewables in 2024). Renewable addition sizes across these six portfolios range from 150 MWa to 250 MWa.
- **Capacity resource additions:** All seven of the best performing portfolios incorporate capacity additions prior to 2025. Capacity is provided by battery storage in four portfolios, a simple-cycle combustion turbine (SCCT) in two portfolios, and three LMS100 units in one portfolio. The portfolios that incorporate battery storage add incremental capacity in both 2024 and 2025, while the portfolios that add thermal resources for capacity make a single larger capacity addition in 2024 due to thermal unit sizes. Capacity additions through 2025 range

between 238 and 299 MW in the portfolios that include storage and between 279 MW and 347 MW in the portfolios that add thermal units. Remaining capacity needs are met with the Capacity Fill resource described in Section 1 Resource Adequacy.

We designed an additional portfolio, the Mixed Full Clean portfolio, to capture the most common elements across the best performing portfolios. The Mixed Full Clean portfolio met all of the screening criteria and performed among the best performing portfolios on the basis of the traditional cost and risk metrics—making it our preferred portfolio. In this portfolio, we meet our resource needs (after accounting for DERs and potential capacity contracts) with a combination of renewable resources and energy storage. Specifically, we add 150 MWa of additional wind in 2023 that qualifies for the 60 percent PTC and approximately 250 MW of energy storage by 2025 that has a duration of at least six hours. Table ES-3, Table ES-4, and Table ES-5 summarize the cumulative components of the preferred portfolio in more detail.

TABLE ES-3: Cumulative customer resource additions in the preferred portfolio

	Reference Case			Low Need			High Need		
	2023	2024	2025	2023	2024	2025	2023	2024	2025
Energy Efficiency (MWa)*	108	133	157	111	140	167	108	133	157
Demand Response[†]									
Summer DR (MW)	190	202	211	329	359	383	104	106	108
Winter DR (MW)	129	136	141	263	282	297	72	73	73
Dispatchable Standby Generation (MW)	136	137	137	136	137	137	136	137	137
Dispatchable Customer Storage (MW)	2.2	3.0	4.0	7.3	9.1	11.2	1.1	1.6	2.2

*Energy efficiency savings reflect the forecast of deployment by the end of the year and are at the meter.

[†]Distributed Flexibility values are at the meter.

TABLE ES-4: Cumulative renewable resource additions in the preferred portfolio

	Reference Case			Low Need			High Need		
	2023	2024	2025	2023	2024	2025	2023	2024	2025
Wind Resources									
Gorge Wind (MWa)	41	41	41	41	41	41	41	41	41
WA Wind (MWa)	0	0	77	0	0	77	0	0	77
MT Wind (MWa)	109	109	109	109	109	109	109	109	109
Total Renewables (MWa)	150	150	227	150	150	227	150	150	227

TABLE ES-5: Cumulative dispatchable capacity additions in the preferred portfolio

	Reference Case			Low Need			High Need		
	2023	2024	2025	2023	2024	2025	2023	2024	2025
Storage Resources									
6hr Batteries (MW)	0	37	37	0	37	37	0	37	37
Pumped Storage (MW)	0	200	200	0	200	200	0	200	200
Total Storage (MW)	0	237	237	0	237	237	0	237	237
Capacity Fill (MW)	123	79	358	0	0	0	425	423	739
Total Dispatchable Capacity (MW)	123	316	595	0	237	237	425	660	976

ES.6 PGE's Action Plan

The analysis presented in this IRP confirms that amid the rapid technological and market changes being experienced in the West, utilities, including PGE, face large uncertainties in future needs and resource economics. This IRP also demonstrates that PGE can take low-risk, near-term actions to meet near-term needs and set the company on a course to achieve critical long-term goals. In support of our goals and in alignment with our preferred portfolio, we are seeking acknowledgment of the 2019 IRP Action Plan briefly summarized below.

- **Customer resource actions.** Customer participation will be critical to achieving long-term decarbonization at the lowest cost to customers. Based on the findings of the Navigant DER Study, PGE proposes the following actions to support customer participation in demand side management programs.
    - Action 1A. Seek to acquire all cost-effective energy efficiency, which is currently forecasted by the Energy Trust of Oregon to be 157 MWa on a cumulative basis by 2025.
    - Action 1B. Seek to acquire all cost-effective and reasonable distributed flexibility, which is currently forecasted to include, on a cumulative basis:
        - 141 MW of winter demand response (Low: 73 MW, High: 297 MW).
        - 211 MW of summer demand response (Low: 108 MW, High: 383 MW).
        - 137 MW of dispatchable standby generation.
        - 4.0 MW of utility-controlled customer storage (Low: 2.2 MW, High: 11.2 MW).
- **Renewable actions.** Through portfolio analysis, PGE determined the best balance of cost and risk includes a near-term renewable action that contributes to meeting near-term energy and capacity needs as well as long-term renewable obligations and that qualifies for federal tax credits. PGE proposes to pursue the following action to acquire renewable resources:

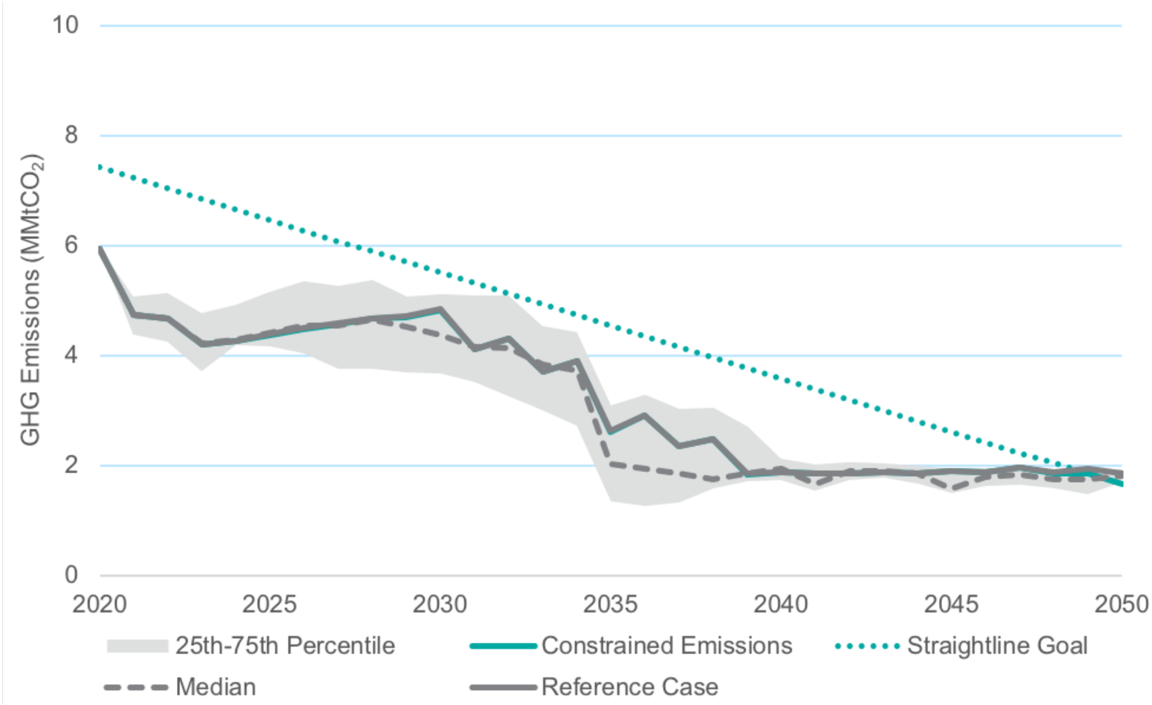
- Action 2. Conduct a Renewables Request for Proposals (RFP) in 2020, seeking up to approximately 150 MWa of RPS-eligible resources to enter PGE's portfolio by the end of 2023. PGE proposes the following conditions as part of this action:
    - The Renewables RFP would be open to all RPS-eligible resources.
    - The Renewables RFP would incorporate a cost-containment screen similar to PGE's 2018 Renewables RFP.
    - PGE would return the value of RECs generated from acquired resources prior to 2030 to customers, similar to the proposal in PGE's 2016 IRP Revised Renewable Action Plan.
    - PGE plans to provide a proposal for transmission requirements for this RFP within the 2019 IRP docket.

- **Capacity actions.** To ensure that PGE can meet our future capacity needs, while taking into consideration the potential impact of uncertainties, PGE plans to conduct the following staged process to secure capacity in the 2024 to 2025 timeframe.
    - Action 3A. Pursue cost-competitive agreements for existing capacity in the region.
    - Action 3B. Update the Commission and stakeholders on the status of PGE's bilateral negotiations and any resulting impacts on capacity needs.
    - Action 3C. Conduct an RFP for non-emitting resources to meet remaining capacity needs.

In addition to meeting our near-term needs, this Action Plan will help us continue on the course to meeting our goal of reducing GHGs by more than 80 percent by 2050. We estimate that the proposed renewable action would avoid approximately 16 million metric tons of GHGs between 2023 and 2050 and would represent 5 to 12 percent of the total additional clean and renewable resources that we need between now and 2050 to hit our goal. The GHG emissions forecast associated with our plan is shown, with uncertainties, in Figure ES-6 below. The trajectory reflects the effects of both near-term and outer year renewable additions, the effects of ceasing coal-fired operations at Boardman by the end of 2020, the exit of Colstrip Units 3 and 4 from our portfolio no later than the end of 2034,[16] and the impacts of a potential future cap and trade program in Oregon. Our analysis suggests that with continued effort to deploy energy efficiency, implement Senate Bill 1547, and respond to potential climate and clean energy policies, we would be on course to stay close to or below our target emissions trajectory between now and 2050.

[16] In Chapter 1, we explore additional sensitivities related to Colstrip's inclusion in our portfolio over time.

FIGURE ES-6: Greenhouse gas emissions forecast



ES.7 Conclusion

Throughout the 2019 IRP, we aimed to design an Action Plan that reflects our values, responds to customer and stakeholder feedback, and embraces the positive change that continues to shape the electric utility industry. Oregon's traditional, yet robust, IRP framework has aided us in these efforts. In some cases, we have proposed evolutions in how this framework may adapt to the shifting demands of customers and the opportunities afforded by new technologies. Our proposed Action Plan allows us to continue pursuing low-cost and clean technologies to benefit customers, while mitigating future risks. Our plan also gives us the flexibility to adapt and learn as conditions change and new opportunities arise. More importantly, the Action Plan provides clarity on our priorities and invites further conversation with customers, stakeholders, and the Commission. We look forward to working together in this IRP and in future planning efforts to chart the course toward a clean, affordable, and reliable energy future.

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