PORTLAND GENERAL ELECTRIC

2019 INTEGRATED RESOURCE PLAN

OPUC Public Hearing
August 13, 2019

Today's Agenda

- How we got here – 2016 IRP Order and our process at a glance
- What we heard – Stakeholder engagement in the 2019 IRP
- What we changed – IRP themes and innovations
- What we found
  - Growing resource needs
  - Shifting resource economics
  - Portfolio analysis
- Preferred Portfolio
  - Meeting near-term needs
  - Renewable glide path
- Action Plan
  - Customer actions
  - Renewable actions
  - Capacity actions

PGE

How we got here

2016 IRP Order

In addition to resource actions, the 2016 IRP Order included enabling studies and additional items to support the next IRP:

- ✓ Flexible Capacity and Curtailment Metrics – Sections 1.4.1, 4.6, 6.1.3, 6.2.2, and External Study F
- ✓ Customer Insights – Sections 1.4.2 and 2.1.2
- ✓ Decarbonization – Sections 1.4.3 and 7.4.1, and External Study A
- ✓ Risks Associated with Direct Access – Sections 1.4.4 and 4.7.3
- ✓ Treatment of Market Capacity – Sections 1.4.5, 2.4.2.1, and External Study E
- ✓ Accessing Resources from Montana – Sections 1.4.6, 5.2.1, and 5.5.4
- ✓ Load Forecasting Improvements – Sections 1.5.1, 4.1, and Appendix D
- ✓ Portfolio Ranking and Scoring Metrics – Sections 1.5.2 and 7.2
- ✓ Distributed Resources – Section 1.5.3, 4.1.3, 5.1, and External Study C
- ✓ Boardman Biomass – Section 1.5.4

How we got here

Our process at a glance

What we heard

Stakeholder engagement in the 2019 IRP

Strong participation across a wide range of groups and individuals

- 221 attendees at 14 public meetings, 58 written comments, five unique portfolio requests

Stakeholder values shared at the outset of our process

- Cost and risk
- Environmental sustainability
- Transparency

Key topics of interest raised throughout the process

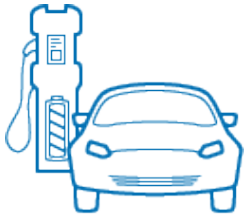
- External Studies: Decarbonization Study
- Resource Options: Wind, storage, and solar + storage assumptions
- Portfolio Analysis: Portfolio requests, portfolio optimization, scoring metrics
- Action Plan: Renewable and capacity actions
- Other: Transmission, procurement activities, Colstrip, and community engagement

More information on feedback received through the roundtable process can be found on PGE's IRP website

What we changed

IRP themes and innovations

Decarbonization



- Decarbonization Study and Decarbonization Scenario
- Electric Vehicle forecasting
- Carbon pricing and carbon-constrained portfolios

Uncertainty and Optionality

- Portfolio analysis considers 810 futures that explore uncertainty in future needs, technology costs, and market conditions
- Value of optionality captured in risk metrics

Customer Decisions

- Distributed Energy Resource (DER) adoption forecasting
- Voluntary renewable program sensitivities
- Direct Access risks

Technology Integration and Flexibility

- Holistic approach to renewable integration costs, flexibility value, and flexibility adequacy
- Consideration of locational value in sensitivity analysis

What we found

Growing resource needs

Load forecast across Need Futures

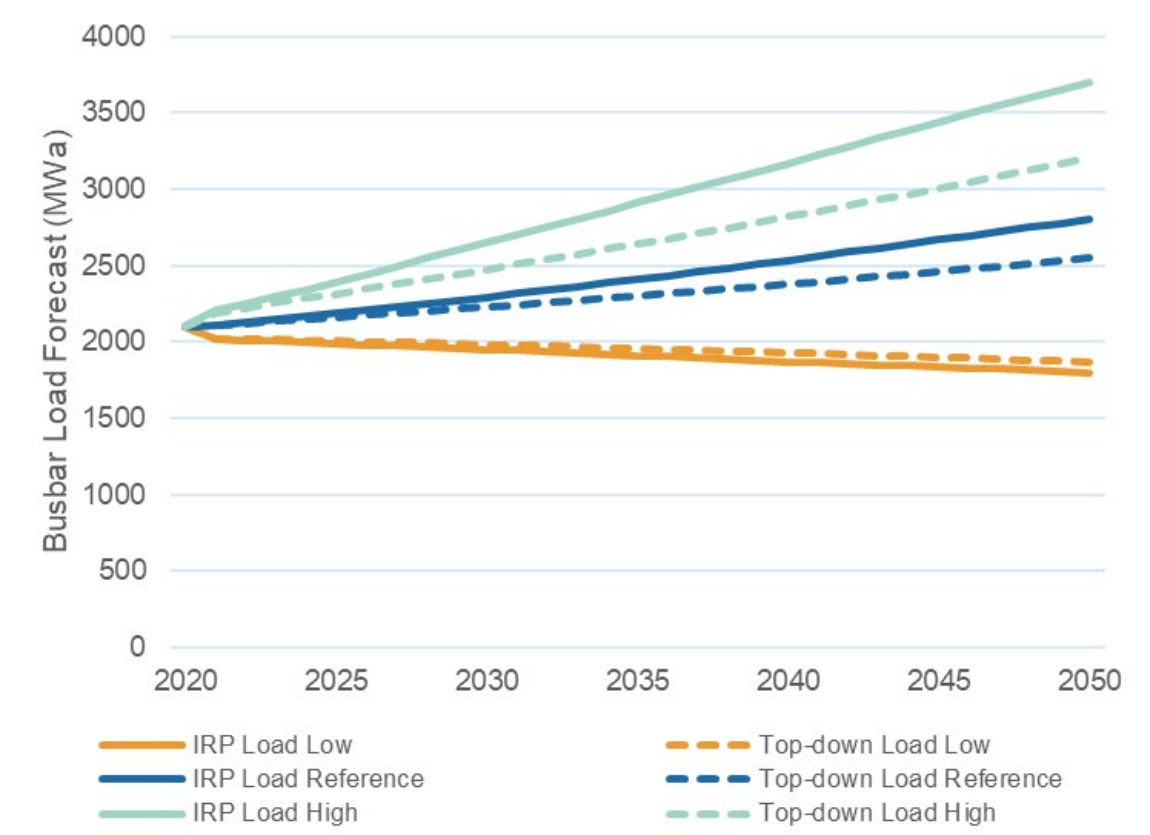


Figure 4-10, 2019 IRP

Variation across load futures is driven by the several factors, including:

- Economic conditions
- Energy efficiency
- Rooftop solar adoption
- Electric vehicle adoption

What we found

Growing resource needs – Capacity

Capacity needs across Need Futures

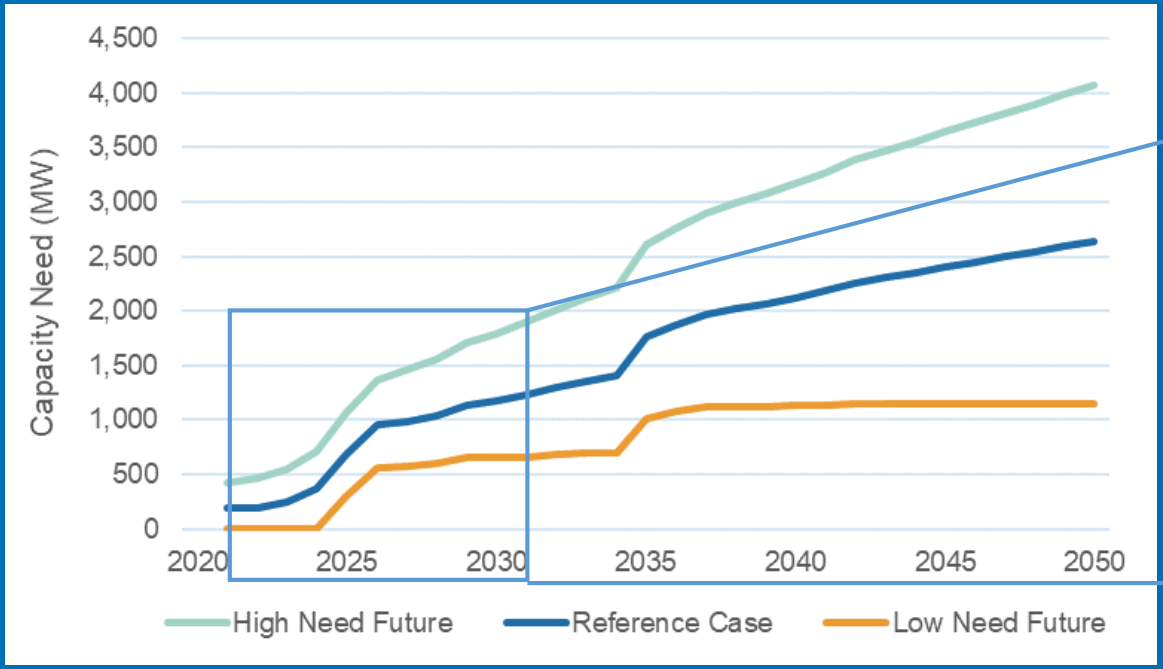


Figure 4-13, 2019 IRP

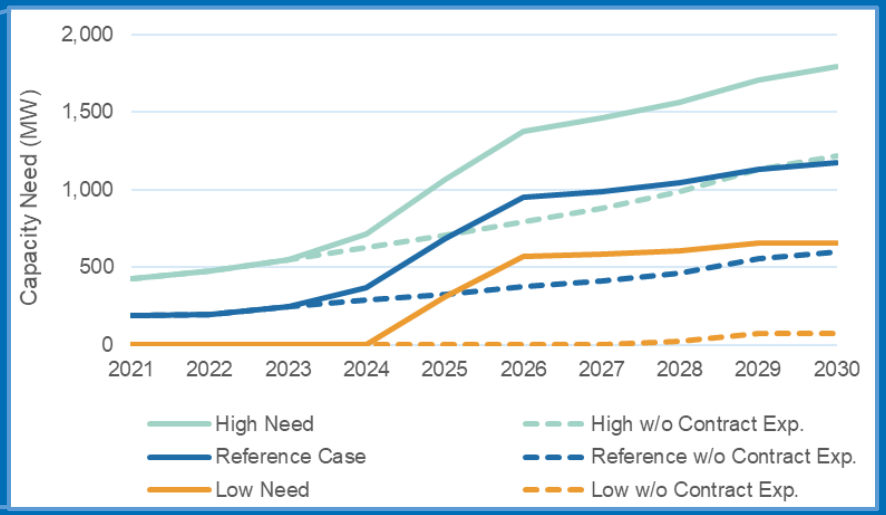


Figure 4-15, 2019 IRP

- **685 MW of capacity need after accounting for DERs by 2025 in the Reference Case**
- **Uncertainty in load and DERs drives variation across capacity need futures**
- **Contract expirations drive approximately 350 MW of capacity needed through 2025**

What we found

Growing resource needs – Energy

Energy shortage to market across Need Futures

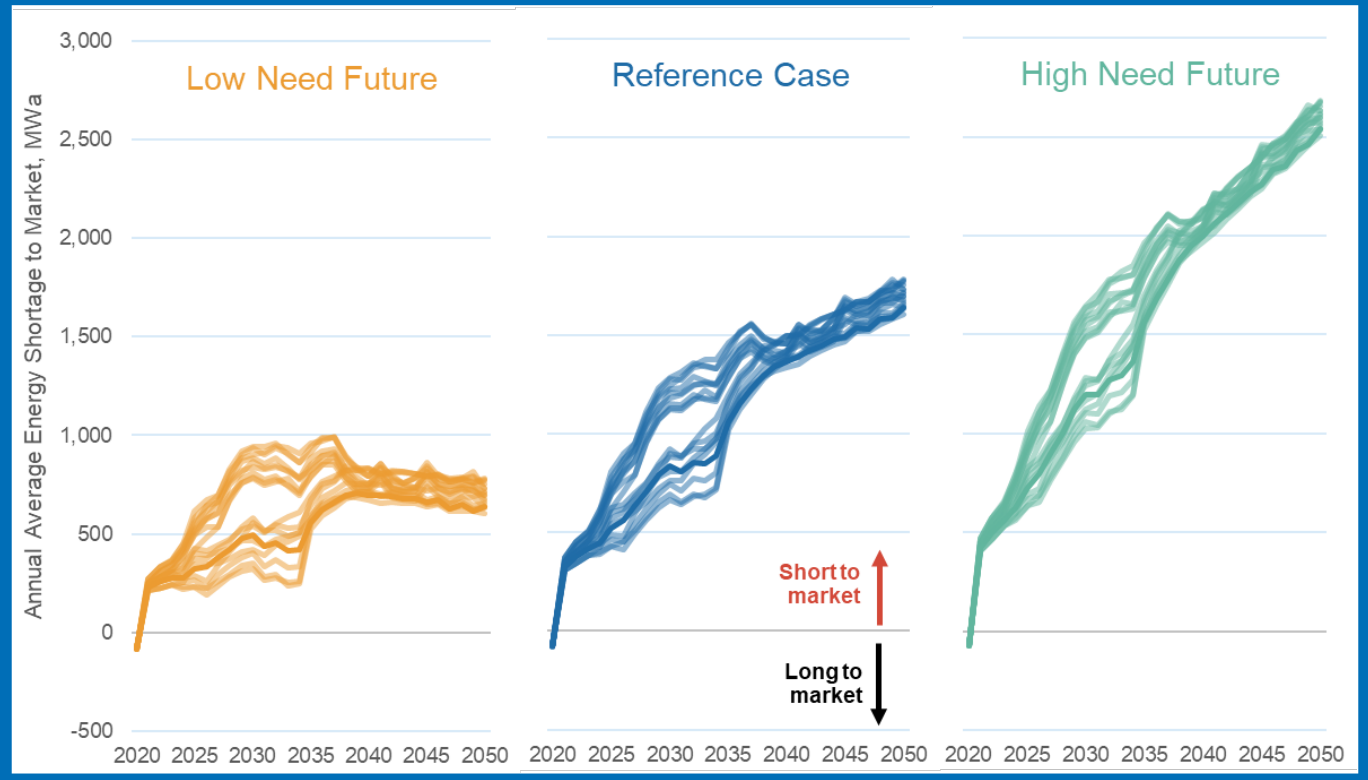


Figure 4-18, 2019 IRP

	2025 shortage to market, MWa
Reference Case	515
10th Percentile	344
90th Percentile	907

- **Forecasted shortage to market in 2025 is greater than 344 MWa in 90% of futures**
- **Market shortage generally grows over time across futures**

What we found

Growing resource needs – RPS

RPS position across Need Futures

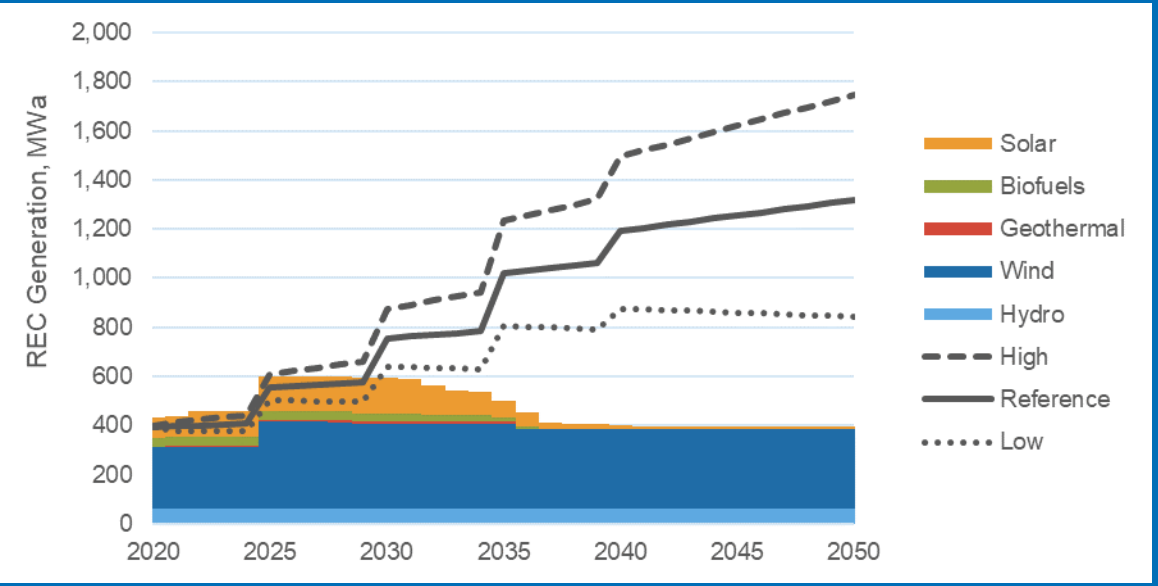


Figure 4-19, 2019 IRP

	2030 physical RPS shortage (MWa)
Reference Case	161
Low Need Future	47
High Need Future	282

	Average annual addition size for 2040 physical compliance (MWa)
Reference Case	42
Low Need Future	25
High Need Future	58

- **A strategy of REC bank depletion could facilitate RPS compliance through 2035, but would require approximately 1,500 MW of wind or 2,500 MW of solar by 2037**
- **IRP portfolios instead require physical RPS compliance on a planning basis to ensure continued steady progress toward long-term targets**

What we found

Shifting resource economics

Derivation of net cost of 100 MWa WA Wind (Reference Case)

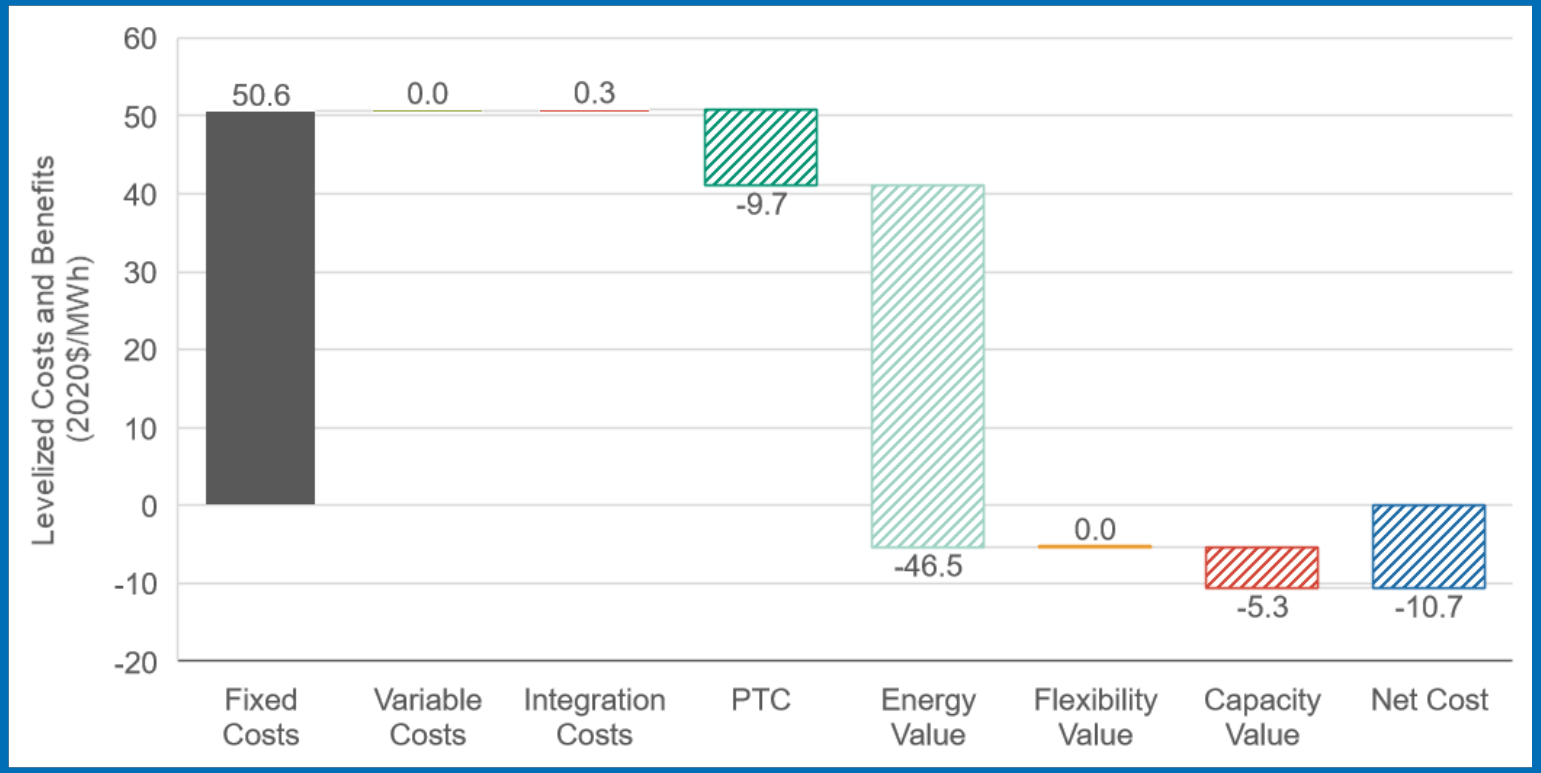


Figure 6-8, 2019 IRP

- **IRP analysis considers the cost of each resource net of value**
- **Some renewable resources may have negative levelized net costs (i.e., forecasted levelized benefits exceed levelized costs)**

* Renewable resources are assumed to come online by December 31 in the year prior to the listed COD to qualify for federal tax credits

What we found

Shifting resource economics

Levelized net cost of energy resources

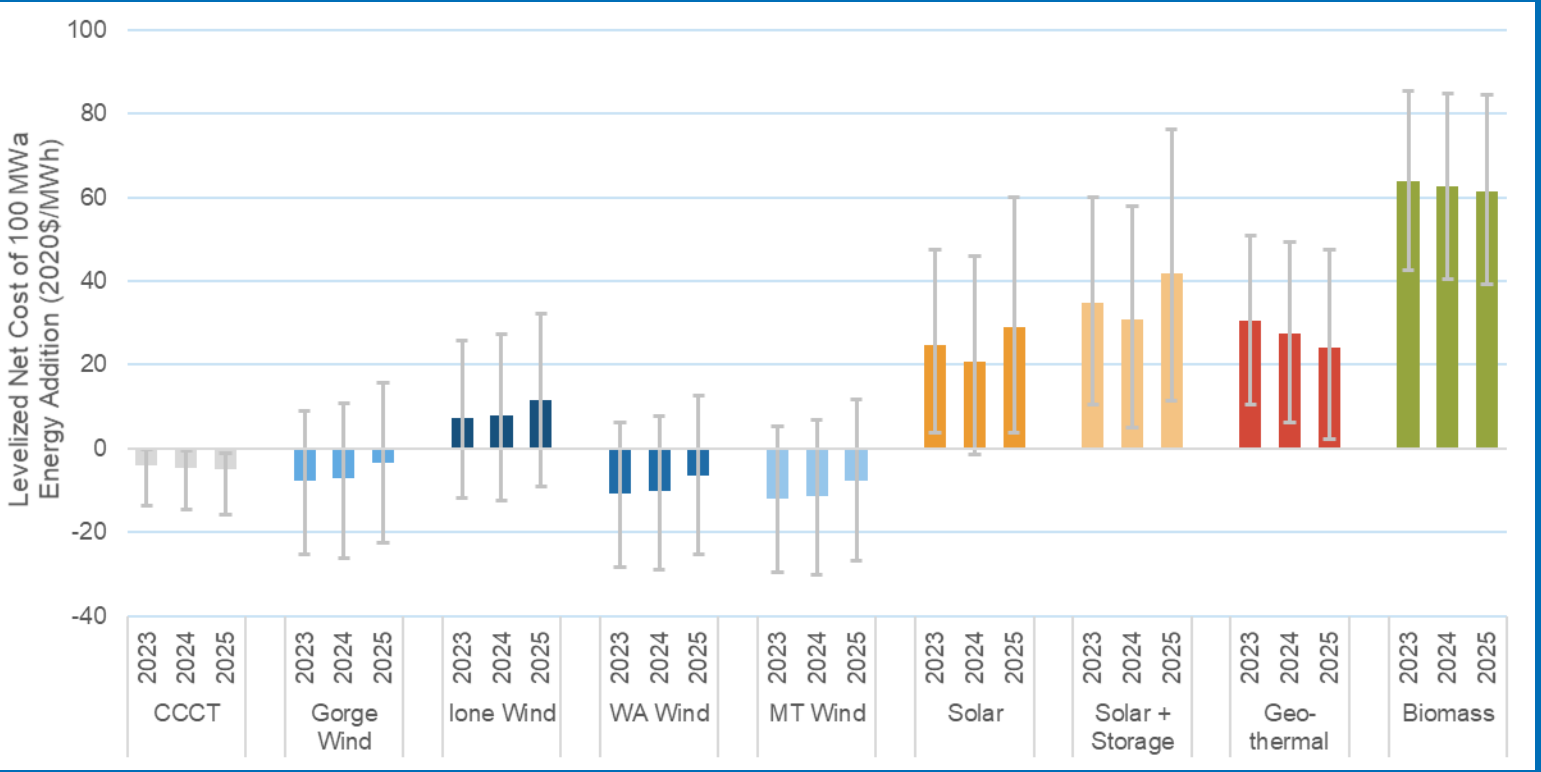


Figure 6-9, 2019 IRP

- **Renewable resources are forecasted to be the lowest cost energy resources on a levelized net cost of energy basis**
- **Resource net cost changes across technology and price futures**

* Renewable resources are assumed to come online by December 31 in the year prior to the listed COD to qualify for federal tax credits

What we found

Portfolio analysis

- PGE tested 43 portfolios across 810 futures that explored uncertainties in future needs, technology costs, and market conditions
- 32 portfolios were designed to compare across:
  - Renewable resource types
  - Dispatchable capacity types
  - Renewable addition size and timing options
- 11 portfolios utilized portfolio optimization to gain further insights
  - Stakeholders in the 2016 IRP suggested that PGE use optimization to create portfolios
  - Optimized portfolios tested various objective functions and constraints and addressed stakeholder requests:
    - Minimize cost, risk, GHGs + cost
    - Allow or disallow thermal resources

What we found

Portfolio analysis

- To develop portfolios, PGE utilized ROSE-E, a new capacity expansion model
- Allows for flexible portfolio construction based on future developments
- Preserves optionality going forward

Example of flexible portfolio construction

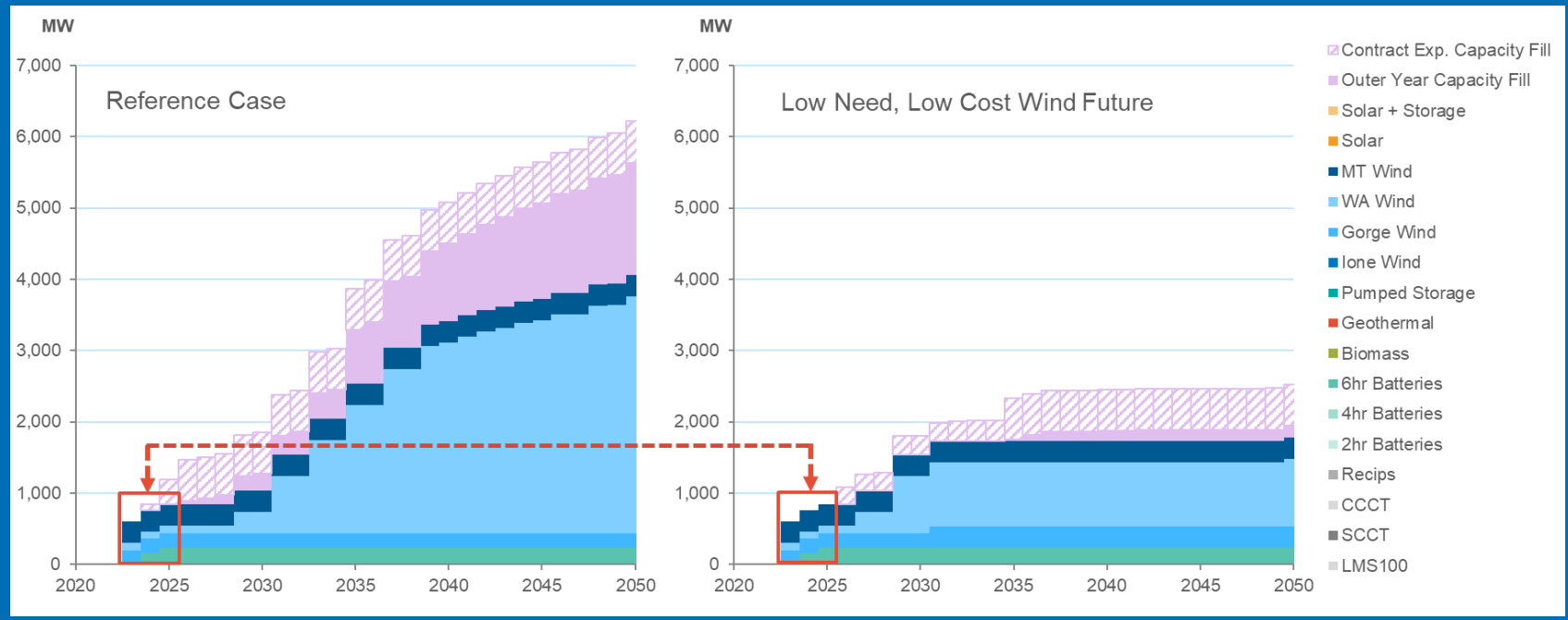


Figure 7-2, 2019 IRP

What we found

Portfolio analysis

Resource additions through 2025 across portfolios

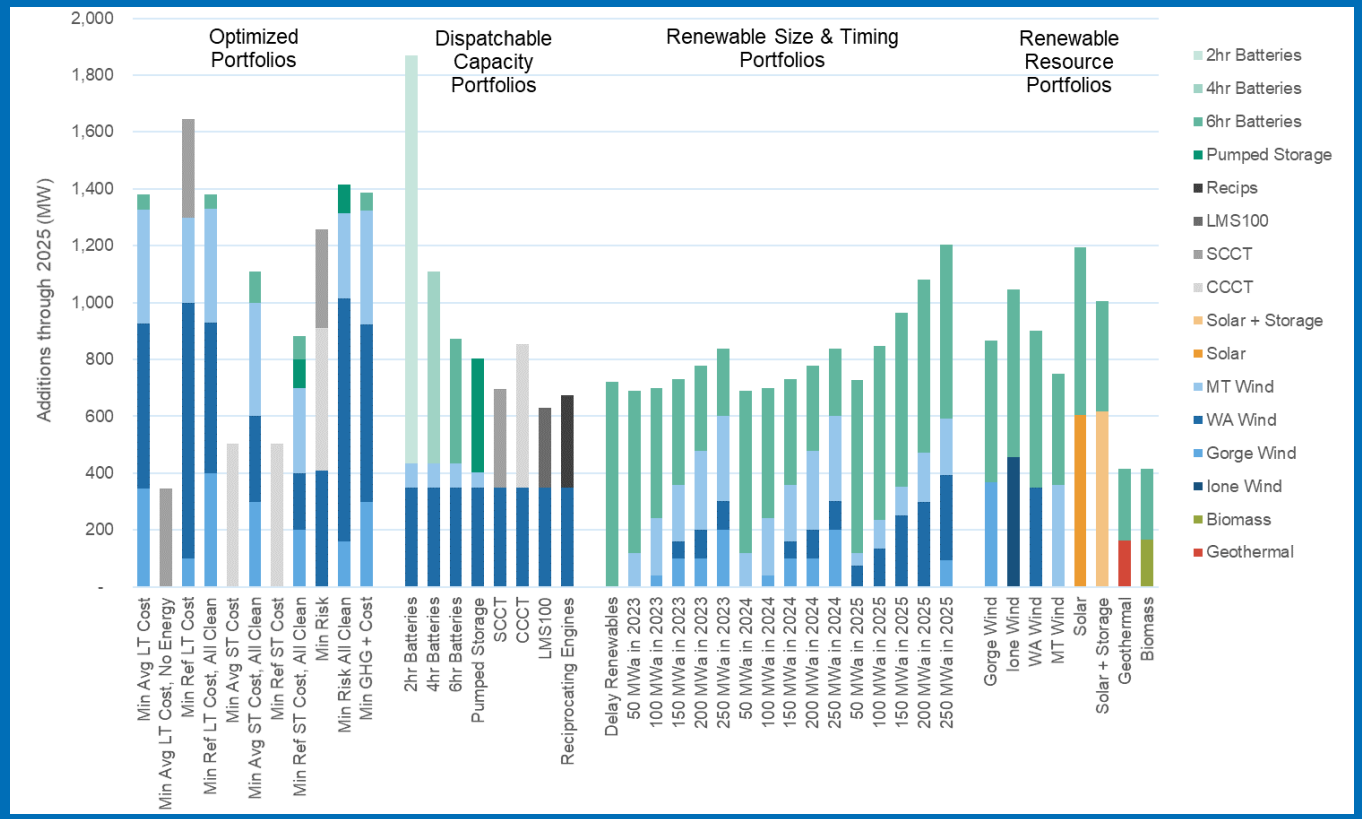


Figure 7-7, 2019 IRP

A multi-stage scoring process was used to determine the preferred portfolio

1. **Screening** based on performance across Non-Traditional Scoring Metrics
2. **Evaluation** based on Traditional Cost and Risk Metrics
3. **Identification** of common aspects of well-performing portfolios
4. **Selection** of a Preferred Portfolio

What we found

Portfolio analysis

Cost vs. variability performance

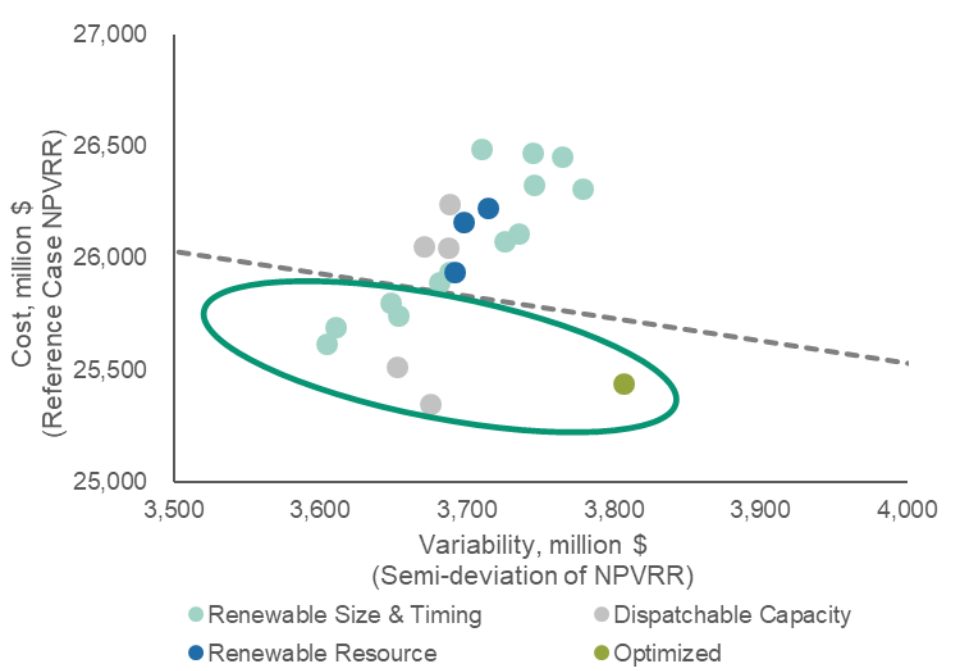


Figure 7-9, 2019 IRP

Near-term resource additions in best performing portfolios

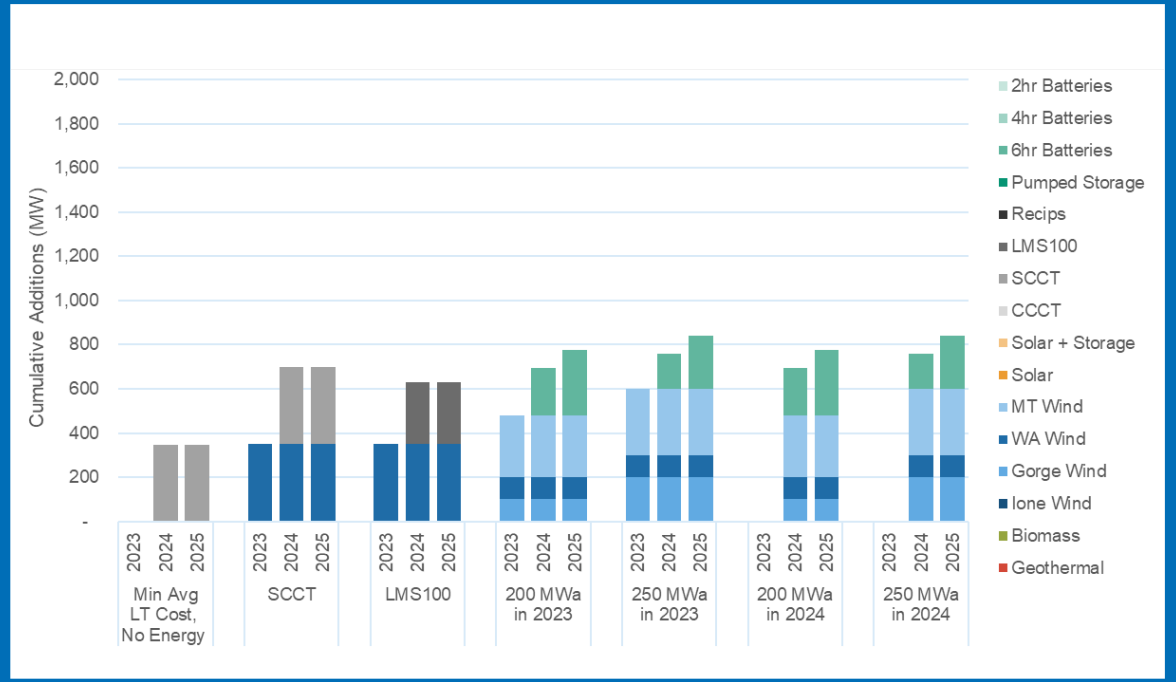


Figure 7-11, 2019 IRP

Seven portfolios met the screening criteria and performed best on the basis of cost and risk

What we found

Portfolio analysis

- **Customer Resources:** All portfolios include all cost-effective energy efficiency and all forecasted DERs from the DER Study
- **Renewable Resources:** Six of the seven best portfolios include renewable additions, ranging in size from 150 MWa to 250 MWa, added in 2023 or 2024
- **Capacity Resources:** Four of the six best portfolios add storage to meet the remaining capacity needs

Near-term resource additions in best performing portfolios

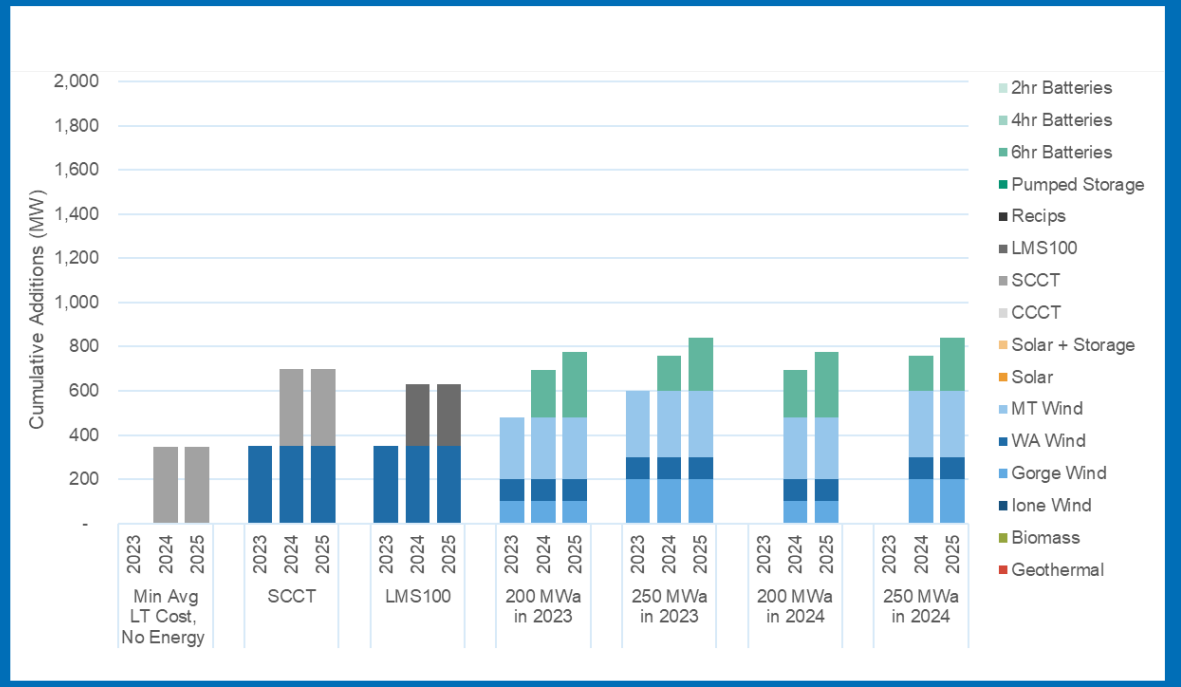


Figure 7-11, 2019 IRP

Seven portfolios met the screening criteria and performed best on the basis of cost and risk

Preferred Portfolio

The Mixed Full Clean portfolio

The Mixed Full Clean portfolio was designed to capture the most common aspects of the best performing portfolios

- **Customer Resources:** The Mixed Full Clean portfolio includes all cost-effective energy efficiency and all forecasted DERs from the DER Study
- **Renewable Resources:** The Mixed Full Clean portfolio includes a 150 MWa renewable addition in 2023
- **Capacity Resources:** The Mixed Full Clean portfolio meets remaining near-term capacity needs with 6+ hour energy storage

Near-term additions in Mixed Full Clean portfolio

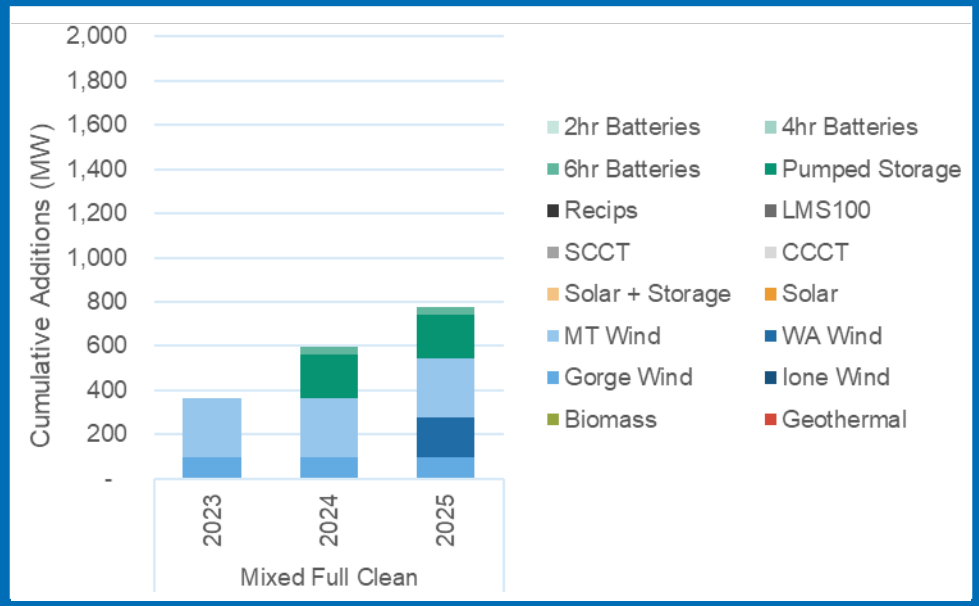
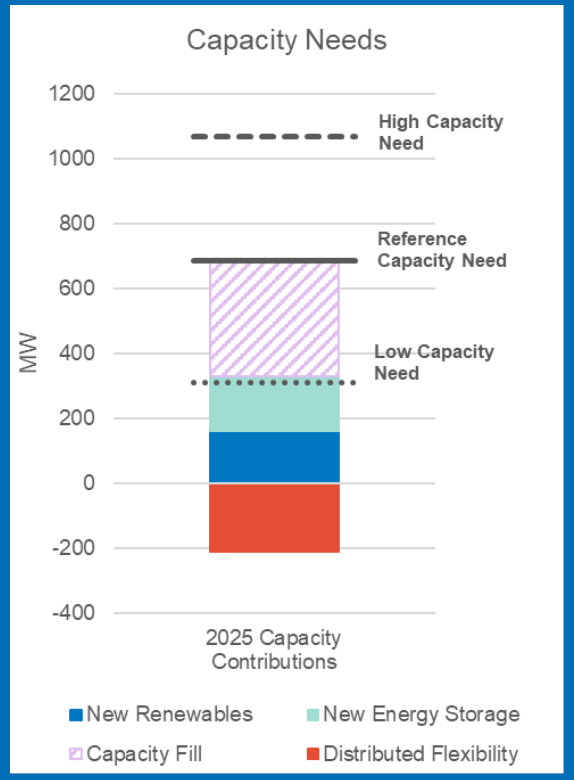


Figure 7-12, 2019 IRP

Preferred Portfolio

Meeting near-term needs

Contribution of resources in preferred portfolio to 2025 needs



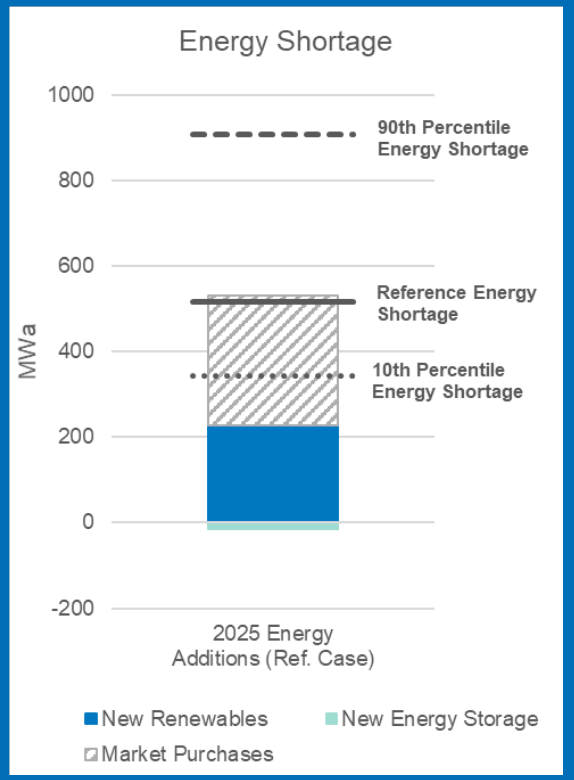


Figure 7-17, 2019 IRP

- **Preferred portfolio meets capacity needs with renewables, storage, and capacity fill**
  - Capacity fill resource provides flexibility to accommodate capacity from contracts, additional DERs, or other reductions in expected need
- **Energy additions in preferred portfolio do not exceed forecasted market energy shortage**
  - Market shortage provides flexibility to accommodate changes in need and additional sources of energy (e.g., voluntary renewable programs)

Preferred Portfolio

Renewable glide path

Renewable glide path in preferred portfolio

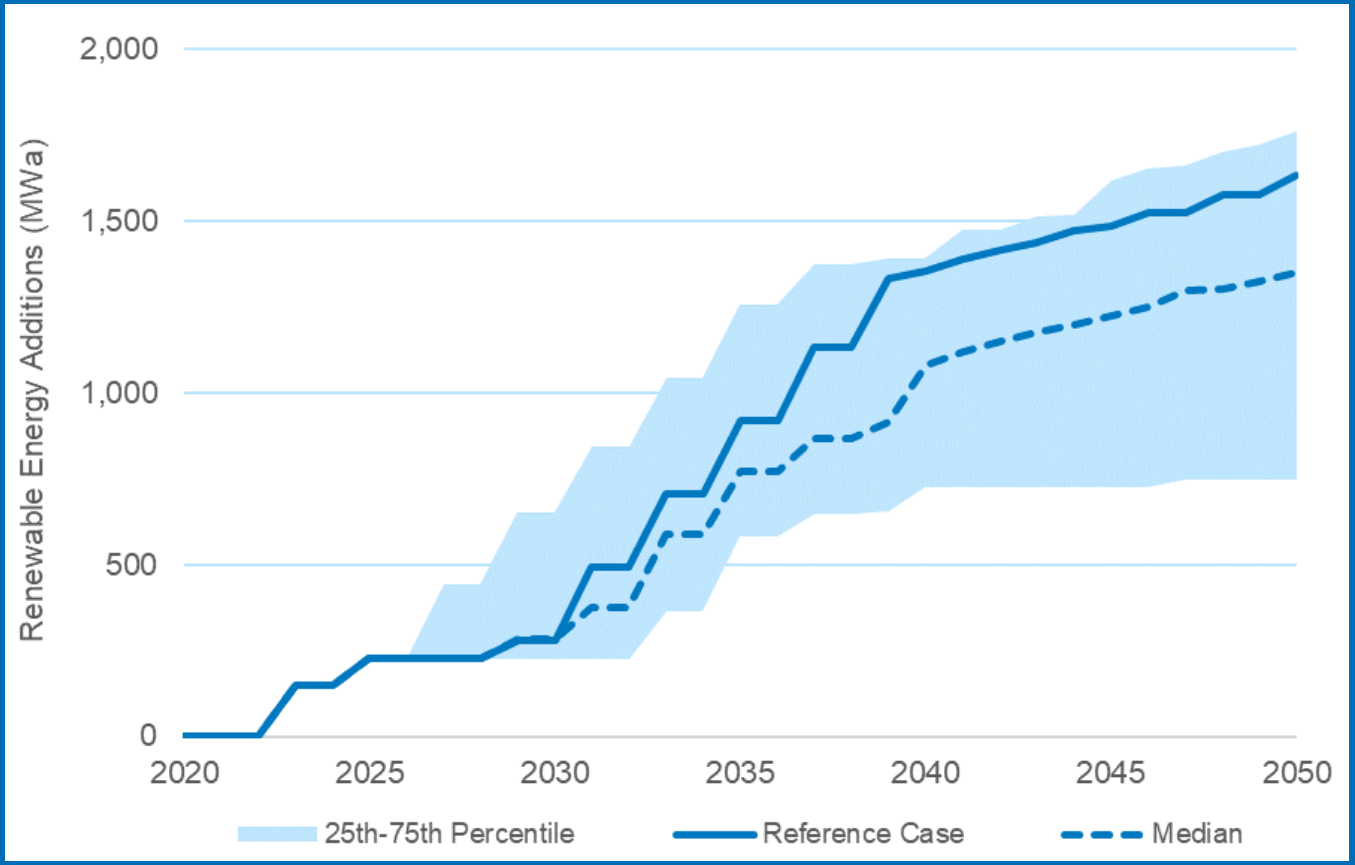


Figure 7-21, 2019 IRP

- Renewable glide path indicates a wide range of future renewable procurement trajectories depending on needs, technology costs, and market conditions
- Near-term renewable addition in the preferred portfolio provides adequate flexibility to optimize future additions across futures

Preferred Portfolio

Greenhouse gas emissions

GHG emissions for the preferred portfolio

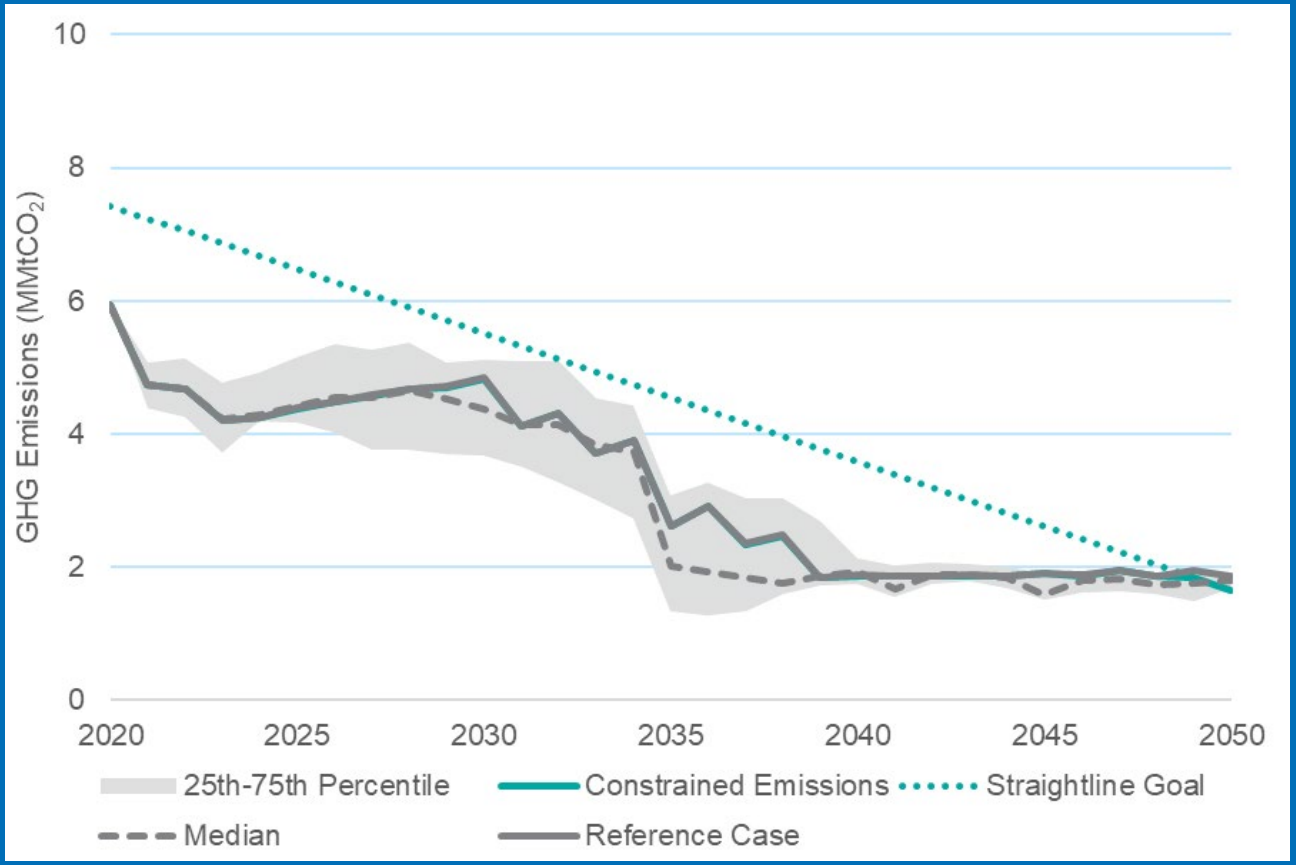


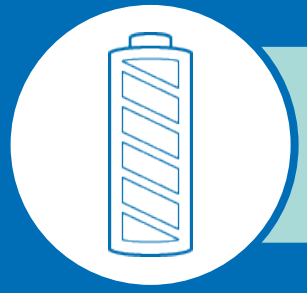
Figure 7-23, 2019 IRP

- **The resource additions in the preferred portfolio help PGE to continue to reduce GHG emissions over time**
- **Forecasted GHG emissions remain close to or below PGE's target emissions trajectory through 2050**

Action Plan

1. Customer Actions

2. Renewable Actions



3. Capacity Actions

Customer Actions

1.A. Seek to acquire all cost-effective energy efficiency, currently forecasted to be 157 MWa by 2025

1.B. Seek to acquire all cost-effective and reasonable distributed flexibility, currently estimated to include, by 2025:

- 141 MW (Low: 73 MW, High: 297 MW) of winter demand response
- 211 MW (Low: 108 MW, High: 383 MW) of summer demand response
- 137 MW of dispatchable standby generation (9 MW incremental)
- 4.0 MW (Low: 2.2 MW, High: 11.2 MW) of dispatchable customer storage

*Values are cumulative and at the meter

Renewable Actions

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

- Timing allows PGE to capture ≥60% PTC for customers
- Open to all RPS-eligible resources
- Propose cost containment screen similar to the 2018 Renewables RFP
- Propose to return value to customers of 2020 RFP resource RECs generated prior to 2030
- Interim approach for transmission

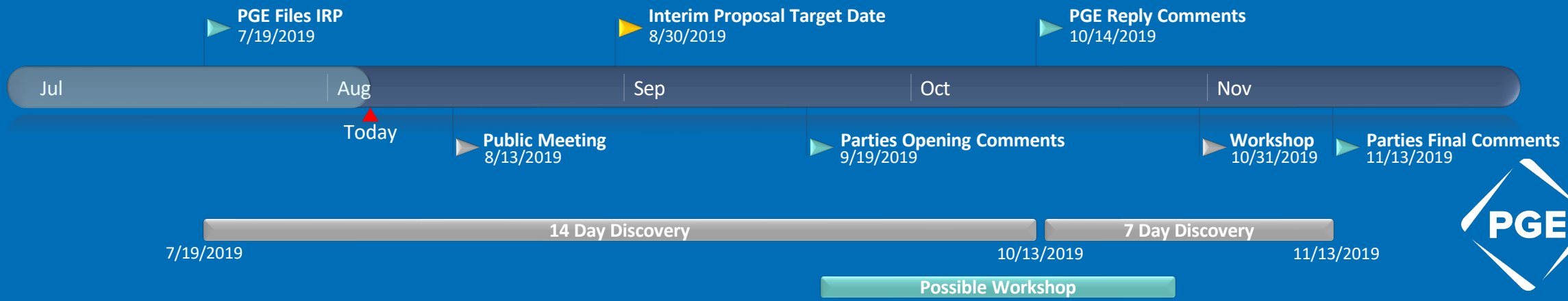
Transmission

An interim solution for the Renewables RFP

- **Cross-functional team developing a "pilot" for renewable resources**
  - Opportunity for learning and better understanding risks
  - Allows for evaluation, adjustment, and off-ramps during pilot period
- **Creating a comprehensive pilot proposal**
  - Currently working to identify and address customer, stakeholder, and PGE impacts
  - RFP scoring methodologies and minimum thresholds, forecasting, cost impacts, etc.
- **End goal of a broader solution to enable continued renewable development**
  - Requires significant time and work beyond the 2019 IRP docket
  - Collaborative and comprehensive approach
  - PGE will bring results from the pilot to help guide the discussion

Transmission
Status of interim solution

- **Seeking to provide our proposal on a schedule that allows for sufficient process and opportunity for comments in this docket**
  - **Target date for addendum filing of August 30th**
  - **Propose holding a workshop between parties' opening and final comments**
- **Will be further reviewed and refined in the Renewables RFP process**



Capacity Actions

3. Pursue a staged procurement process to secure capacity to maintain resource adequacy, while considering the impact of uncertainties

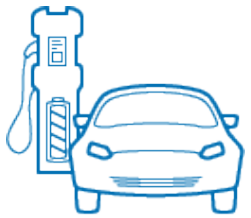
A. Pursue cost competitive existing capacity in the region via bilateral negotiations

B. Update the OPUC and stakeholders on PGE's resource needs in 2020

C. Conduct a non-emitting capacity RFP in 2021 for capacity needs remaining after above actions

Putting it all together

In the 2019 IRP, we designed an Action Plan that reflects our values, responds to customer and stakeholder feedback, and embraces the positive change that is shaping our industry



Decarbonization

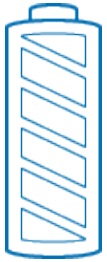
The Action Plan provides PGE the opportunity to further decarbonize at low cost to customers if cost competitive resources are available in the market

Uncertainty and Optionality

The Action Plan allows PGE to respond flexibly as resource needs and conditions evolve, while maintaining optionality for future resource decisions

Customer Decisions

The Action Plan supports customer participation in the grid through expanded energy efficiency and distributed flexibility



Technology Integration and Flexibility

The Action Plan allows PGE to leverage new clean and flexible technologies, like energy storage and demand response

Thank you

For additional information, please contact us at IRP@pgn.com
or visit us online at http://www.portlandgeneral.com/IRP