Integrated Resource Planning

ROUNDTABLE 23-3
MARCH 2023

March 30, 2023 – Agenda

9:00 – 9:15	Welcome, Introductions & Meeting Logistics
9:15 – 10:00	Avoided Cost Resources
10:00 – 10:30	Final Action Plan, Document
10:30 – 11:30	Study Limitations and Areas of Improvement
11:30 – 11:45	UM 1728 Update
11:45 – 12:00	Closing Remarks & Next Steps

Meeting Details

1

Electronic version of presentation

https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning/irp-public-meetings

2

Zoom meeting details

- Join Zoom Meeting https://us06web.zoom.us/j/84391255924?pwd=RDQ2VFpUZERVSEcraU5CZWw3VDhQZz09
- Meeting ID: 843 9125 5924
  Passcode: 108198

3

Participation

Use the raise hand feature to let us know you have a question

Unmute with microphone icon or *6 on phones

MEETING LOGISTICS

Focus on learning & understanding

Team members will take clarifying questions during the presentation
Attendees will not have access to the chat feature during the meeting in order to streamline taking feedback
Attendees are encouraged to "raise" their hand to ask questions

Questions & answers

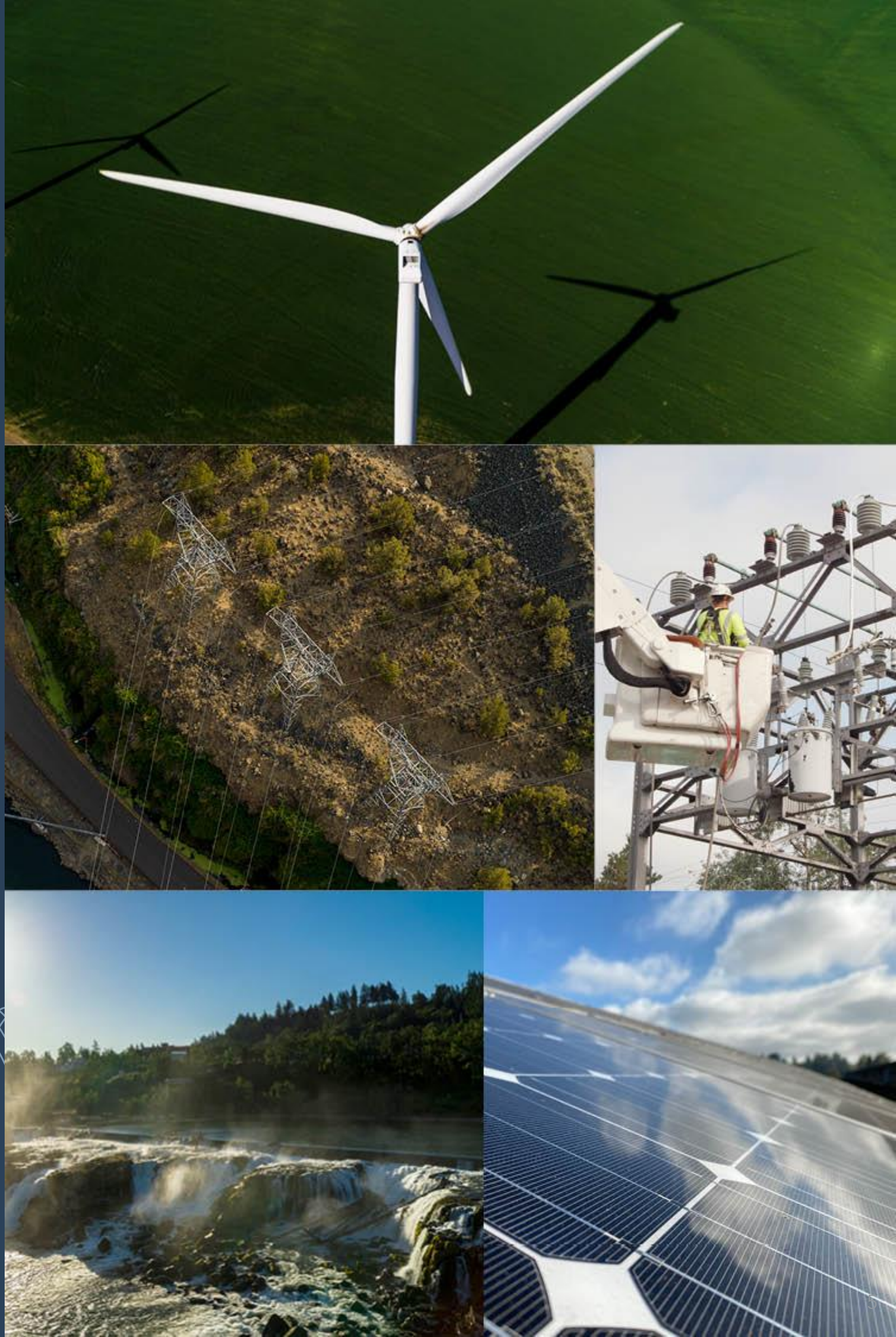
Time will be dedicated at the end of each presentation to address questions and comments

Follow up

If we don't have time to cover all questions, we will provide answers via the monthly published feedback form

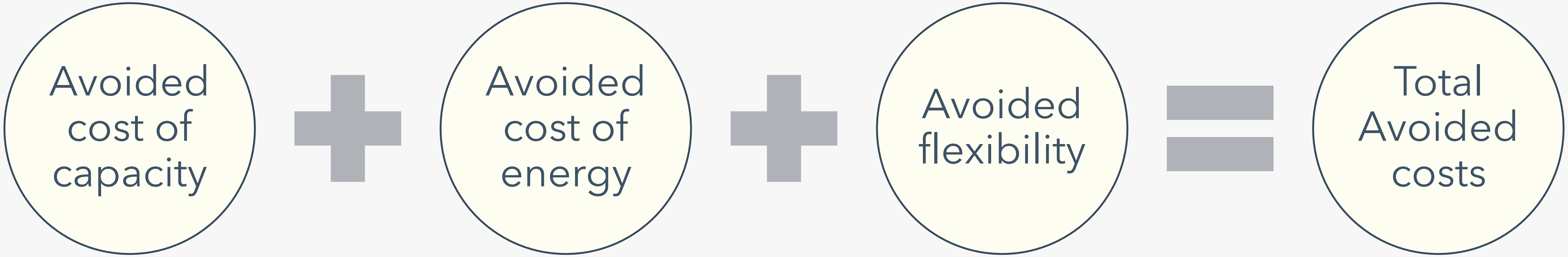
Avoided Cost Resources

NIHIT SHAH, PGE



PGE An Oregon kind of energy.℠

Breaking down avoided costs



Capacity value

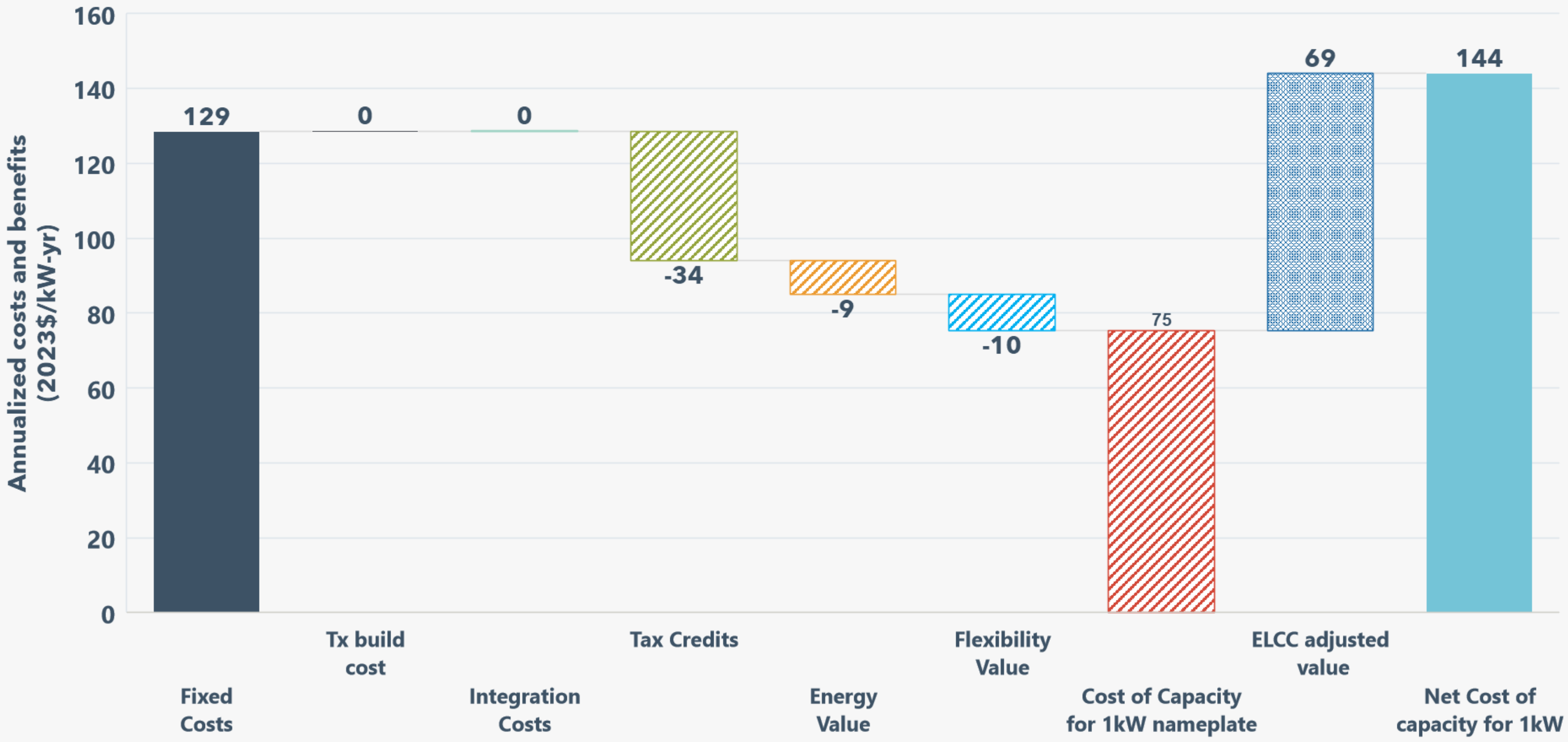
Definition - The cost to acquire 1 kilowatt (kW) of capacity contribution from the next least cost capacity resource available

In 2026, the 4hr battery is the least cost resource available to provide capacity

The preferred portfolio adds 232MW of 4hr battery in 2026

232MW nameplate of storage has an ELCC of 52%

Deriving the net cost of 1 kW of capacity contribution from a 4-hour battery (2026 COD)



Capacity benefit of different resources

ELCC for energy resources is calculated at 100MWa of energy

ELCC for capacity resources is calculated at 100MW of capacity contribution

Resource	Annual ELCC for 100 MWa energy addition	Capacity value (2023$/MWh)
Gorge Wind	39%	15
Montana Wind	39%	15
SE Washington Wind	23%	9
Christmas Valley Solar	14%	9
McMinnville Solar	16%	12
Wasco Solar	14%	9
Resource	**Annual ELCC for 100 MW capacity addition**	**Capacity value (2023$/kW-yr.)**
Energy efficiency bin 2	108%	156
Energy efficiency bin 1	118%	169
Christmas Valley 1:1 solar hybrid	78%	112
McMinnville 1:1 solar hybrid	78%	113
Nevada Solar + market access	100%	144
Wyoming Wind + market access	100%	144

Energy value

Current methods estimate energy value in one of two ways:

Assuming market access as backstop to procure energy. Energy value involves summing the hourly resource generation with market prices.

The second involves determining the net cost of a new off-system VER. However, this option is only applied to resources assuming available transmission capacity.

	Levelized energy value (2023$/MWh)	
Resource	**Reference case**	**Range**
Solar PV Christmas Valley	$17.78	$2.83 - $30.08
Solar PV McMinnville	$16.85	$2.68 - $28.7
Solar PV Nevada	$19.51	$3.12 - $32.72
Solar PV Wasco	$16.50	$2.62 - $28.13
Wind Gorge	$21.97	$3.54 - $36.8
Wind MT	$26.39	$4.26 - $43.4
Wind SE Washington	$24.34	$3.92 - $40.28
Wind Wyoming	$27.18	$4.39 - $44.64
Wind Offshore	$23.55	$3.79 - $39.29

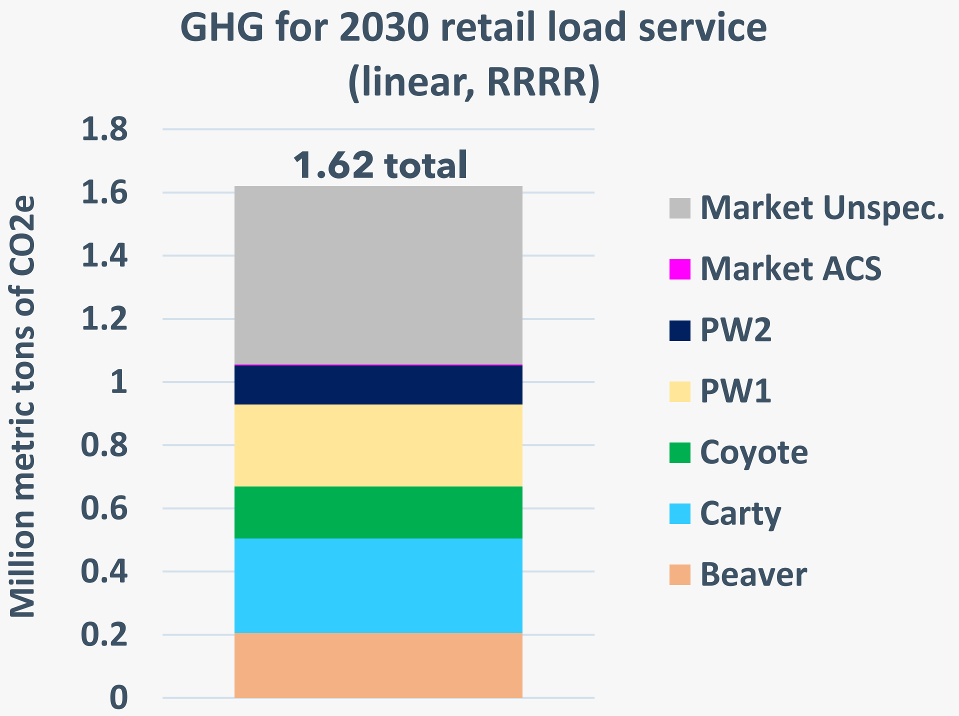
HB 2021 - Emissions accounting

Total GHG emissions are a function of two components:

1. **Thermal generation**: economic dispatch from by Aurora, then a portion allocated to retail sales
2. **Market activity**: based on historic levels of market purchases/sales and carbon specification

Aggregated they comprise the entirety of our available emissions budget

Incremental resources must be carbon free, or replace existing thermal generation or purchases



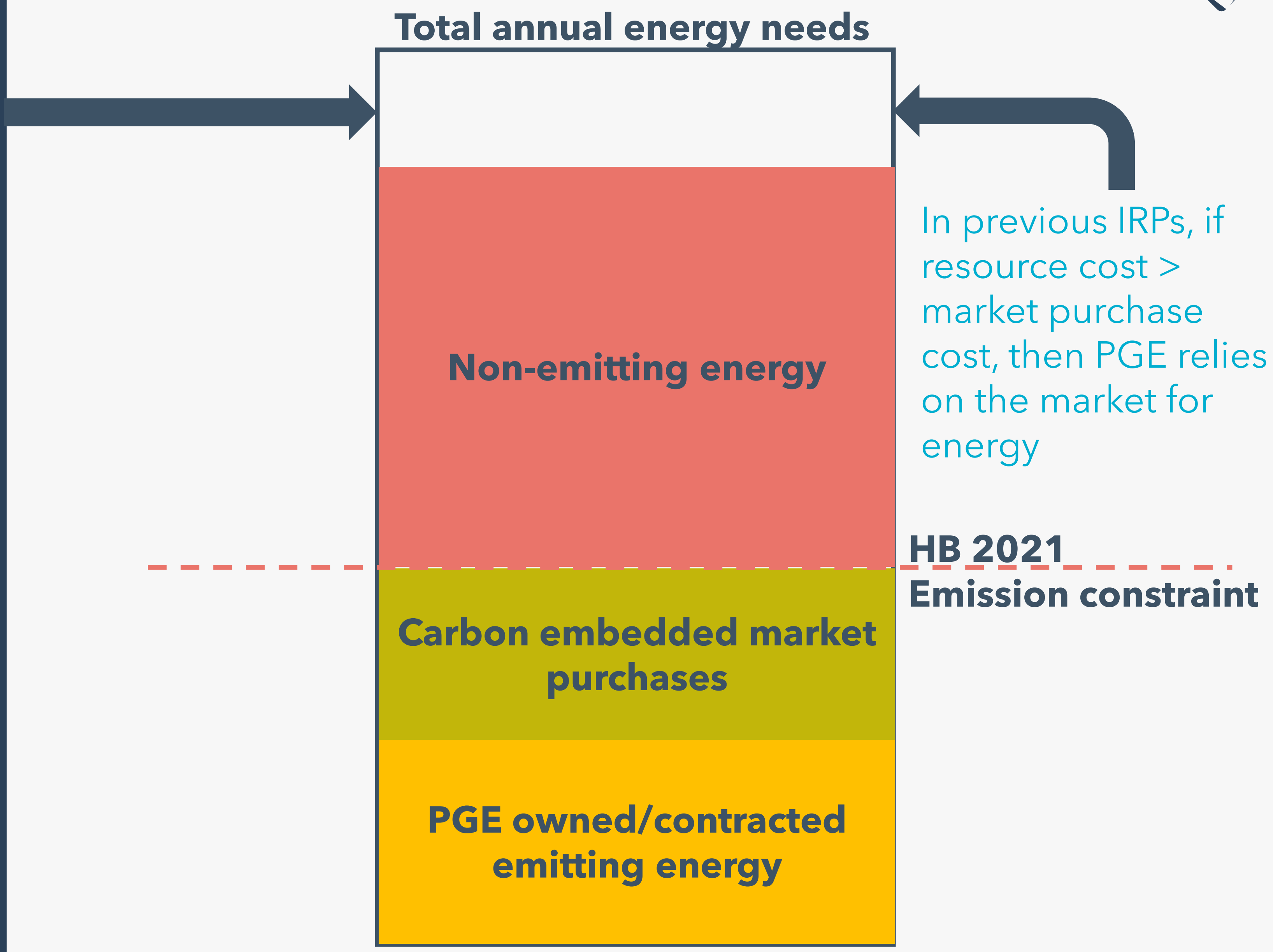
Cost of clean energy

HB2021 constraints limit access to market purchases with embedded carbon content.

Thus, if the total energy needs of the system surpass the energy generated by both the existing non-emitting resources and the carbon-embedded energy, the model must rely on **adding incremental non-emitting generating resources to meet energy need**.

This represents a new cost associated with meeting energy needs through non-emitting resources. Conversely, this is a value to resources that avoid this new cost.

Illustrative figure



Takeaways

PGE

The method to determine the avoided cost of capacity remains unchanged

The proxy resource for the new avoided cost of capacity is a 4hr battery, reflecting the current planning environment and the implications of HB 2021

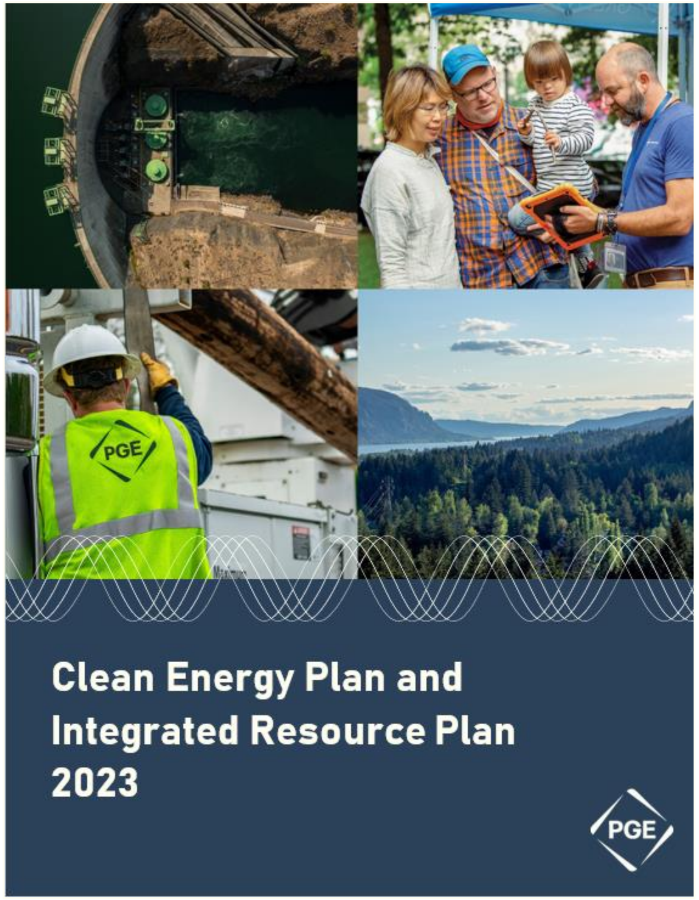
The introduction of HB 2021 results in the need for clean energy, which may cost more than the wholesale price of electricity

Cost of clean energy will become significant once transmission availability decreases

Questions

Final CEP/IRP Action Plan

SETH WIGGINS, PGE



Action Plan: Recap & previous meetings

We first presented on the draft action plan in January 2023

January 2023: five main components of the draft action plan (ppt, video)

March 8, 2023: updates and more details on those five components (ppt, video)

Today: Updates to the years of focus in the Action Plan

- Customer Actions
- Community-Based Renewable Energy Action
- Energy Action
- Capacity Action
- Transmission Expansion

Five Components of IRP/CEP Action Plan

The IRP/CEP Action has five main components

1. Customer Actions
2. Community Based Renewable Energy Action
3. Energy Action
4. Capacity Action
5. Transmission Action

1. Customer Actions

i. Energy Efficiency

- Acquire all cost-effective EE - ETO forecasts a cumulative 150 MWa through 2028 (*estimates from ETO)*

ii. Demand Response

- Incorporate customer additions of 211/158 MW* of summer/winter DR by 2028 (*estimates from DSP pt. II*)

* Demand response values include existing programs

2. Community-Based Renewable Energy Action

CBREs are renewable energy systems that promote climate resilience and:

- Provide direct community benefit through a benefits agreement or ownership; or
- Result in increased resiliency or community stability, local jobs, economic development or direct energy cost savings to families and small businesses.

Conduct an RFP for community-based renewable energy resources (CBREs)

- Set up a new RFP process focused on CBREs procurement
- Evaluation and scoring of projects led by communities
- Community benefits are a key element of the scoring matrix

Initial RFP target is 66 MW in 2026

Conduct additional RFP(s) as necessary to support a trajectory towards achieving PGE's goal of 155 MW of CBRE resources by 2030

- Aligned with Multnomah County and City of Portland goals

3. Energy Action

Conduct one or more RFPs for non-emitting energy resources

Current Reference Case 2030 energy need: **905** MWa

PGE will target 20% of that need each year of the action plan (through 2028). This equates to 181 MWa per year, or **543 MWa through 2028**.

- This action assumes the forecasted cost-effective levels of EE will materialize along with other assumed non-IRP resources arriving as forecasted (like the 2021-RFP resources)
- Successful acquisition of CBRE resources reduces this need
- PGE will update these values as new load and resource data are available

4. Capacity Action

Conduct one or more RFPs to meet 2028 capacity needs

Current Reference Case **2028** capacity need: **624** MW summer, **614** MW winter

PGE will pursue capacity opportunities in the bilateral market and conduct one or more capacity RFPs to meet this need

- This action assumes the forecasted cost-effective levels of EE will materialize along with other assumed non-IRP resources arriving as forecasted (like the 2021-RFP resources)
- Successful acquisition of CBRE resources reduces this need
- PGE will update these values as new load and resource data are available

5. Transmission Expansion

Pursue options to alleviate congestion on the SoA flowgate

Current estimates of existing transmission system suggest insufficient transmission capacity available to support the acquisition of off-system resources required for 2030 and beyond

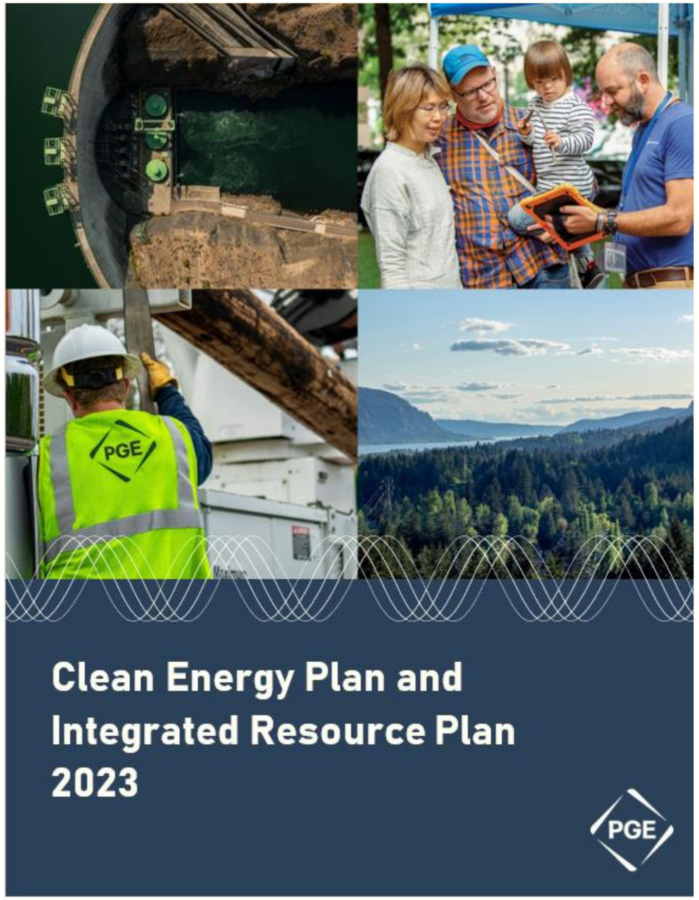
Explore the upgrade of the Bethel-Round Butte line (from 230 to 500 kV)

This option provides near-term relief to transmission constraints and opens access to a diverse set of resources for future PGE load service

Questions

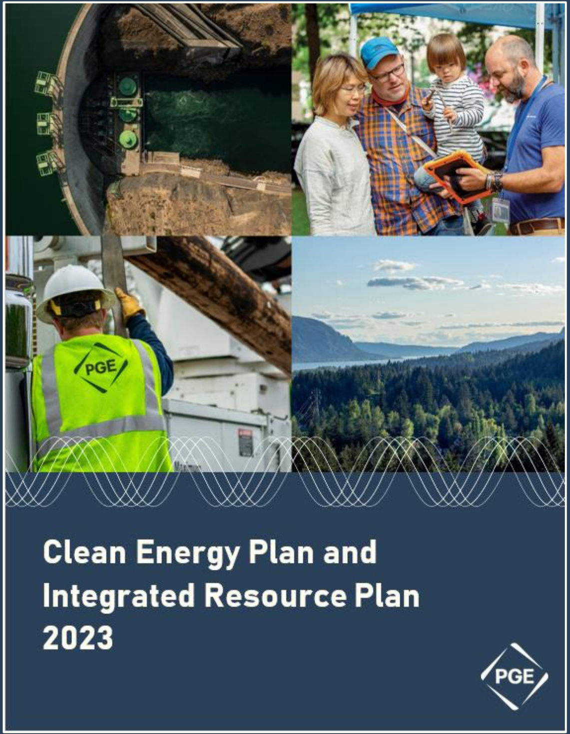
Clean Energy Plan & Integrated Resource Plan Report

SETH WIGGINS, PGE



Clean Energy Plan & Integrated Resource Plan

Filing the Integrated Resource Plan and Clean Energy Plan jointly on March 31, 2023.



Report structure

PGE

14 Chapters

- Chapter 1. Clean energy plan
- Chapter 2. Accessing support for energy transition
- Chapter 3. Planning environment
- Chapter 4. Futures and uncertainties
- Chapter 5. GHG emissions forecasting
- Chapter 6. Resource needs
- Chapter 7. Community Benefits Indicators and Community-based Renewable Energy
- Chapter 8. Resource options
- Chapter 9. Transmission
- Chapter 10. Resource economics
- Chapter 11. Portfolio analysis
- Chapter 12. Action Plan
- Chapter 13. Resilience
- Chapter 14. Community equity lens

16 Appendices

- Appendix A. 2019 IRP action plan in review
- Appendix B. Compliance guidelines
- Appendix C. 2023 IRP public meeting agendas
- Appendix D. Load forecast methodology
- Appendix E. Existing and contracted resources
- Appendix F. Load resource balance
- Appendix G. Market capacity study
- Appendix H. 2023 IRP modeling details
- Appendix I. C-level analysis
- Appendix J. ELCC Sensitivities
- Appendix K. Tuned system ELCCs
- Appendix L. Clean Energy Plan: Learning Labs Community Feedback
- Appendix M. Supply-side options
- Appendix N. Renewable curtailment
- Appendix O. Thermal Operations/ Output
- Appendix P. Acronyms

4 Studies

- ES-I. Deep decarbonization
- ES-II. EE methodology
- ES-III. Climate adaptation
- ES-IV. Flexibility study

Ch 1: Clean energy plan

Chapter 1. Clean energy plan
- 1.1 Aligned planning
- 1.2 Historic emissions trends and resource mix
  - 1.2.1 HB 2021 requirements:
- 1.3 Recent milestones in efforts to decarbonize
- 1.4 Strategies to decarbonize
  - 1.4.1 Clean energy supply
  - 1.4.2 Community and customer-sited solutions
  - 1.4.3 Technology and innovation
  - 1.4.4 Regional solutions to resource adequacy: markets, partnerships, and transmission
- 1.5 Pathway to HB 2021 emissions targets
  - 1.5.1 Portfolio analysis and Action Plan
  - 1.5.2 Pathway to emissions targets
- 1.6 High-level opportunities, potential barriers, critical dependencies

Chapter highlights

- To meet our emissions reduction targets, we need to add non-emitting resources at an unprecedented pace and scale. For the foreseeable future, we will be in a near-continuous procurement cycle to replace GHG-emitting resources and keep pace with new customer demands.
- Achieving GHG reduction targets reliably and affordably requires gradually replacing fossil fuel generation and purchases with non-emitting energy and capacity resources.
- Transmission is a significant factor impacting the economics and timing of resource additions to meet HB 2021 targets reliably.
- Significant transmission constraints will drive a greater role for customer-sited resources such as demand response, energy efficiency, distributed solar/storage, and community-based renewable energy (CBRE) resources, highlighting the importance of PGE's efforts to improve our utilization of these resources through a virtual power plant (VPP).
- 2030 emissions reduction targets can be met by technologies and resources that are currently known and commercially available.
- Pathways to 2040 will require further technological advancement of non-emitting resources and transmission to meet the region's energy and capacity needs.

Ch 2: Accessing support for energy transition

- Chapter 2. Accessing support for energy transition
  - 2.1 Federal support for energy transition
    - 2.1.1 Inflation Reduction Act
    - 2.1.2 Infrastructure Investment and Jobs Act
  - 2.2 State support for energy transition
  - 2.3 Technology and market research

Chapter highlights

- Federal and state policies are helping to drive rapid decarbonization in ways that impact PGE's resource planning.
- Federal legislation such as the IRA and IIJA that expanded and extended tax credits will facilitate PGE's acquisition of new resources and help manage customer rate impacts.
- We are partnering across the energy sector to stay abreast of rapid technological and market changes so that our customers benefit from the rapid change occurring across the energy ecosystem.



Ch 3: Planning environment

- Chapter 3. Planning environment
  - 3.1 Federal and State law and regulatory policy
    - 3.1.1 CHIPS and Science Act
    - 3.1.2 Oregon House Bill 2021
    - 3.1.3 Oregon Climate Protection Program (CPP)
    - 3.1.4 Transportation electrification
    - 3.1.5 Energy efficiency and building decarbonization
    - 3.1.6 Local climate action planning
    - 3.1.7 Regulatory policy: Direct access
    - 3.1.8 Regulatory policy: Power Cost Adjustment Mechanism (PCAM)
  - 3.2 Regional planning: Resource adequacy
    - 3.2.1 Resource adequacy in the IRP compared to the WRAP
  - 3.3 Market, labor, and supplier dynamics
    - 3.3.1 Localized load growth
    - 3.3.2 Workforce availability
    - 3.3.3 Supply chain
    - 3.3.4 Department of Commerce investigation into solar tariff circumvention

Chapter highlights

- Federal and state policy impacts the planning environment for PGE's Integrated Resource Plan (IRP) and Clean Energy Plan (CEP).
- Regulatory policy may need to adapt to changing dynamics created by state and regional decarbonization objectives.
- Thermal resource retirement in Oregon and the West creates challenges for resource adequacy as the region decarbonizes.
- Continued uncertainty related to labor markets, supply chains, and the macroeconomy presents challenges to decarbonization efforts.

Ch 4: Future & uncertainties

Chapter 4. Futures and uncertainties
- 4.1 The changing Western Interconnection
- 4.2 Need futures
- 4.3 Energy technology capital cost scenarios
- 4.4 Long-term fundamental price forecast
- 4.5 Uncertainties in price forecasts
  - 4.5.1 Commodity risk: natural gas prices
  - 4.5.2 Commodity and scarcity risk: hydropower generation
  - 4.5.3 Carbon policies and reduction targets in WECC
  - 4.5.4 Uncertainty and scarcity risk
- 4.6 Addressing uncertainties

Chapter highlights

- Key drivers of uncertainty in this Integrated Resource Plan (IRP) include demand growth, economic trends and technological innovation, rate of electrification and customer adoption of new technologies, regional resource adequacy, and buildout of new non-GHG-emitting resources.
- PGE's portfolio analysis accounts for uncertainty in future resource needs, technology costs, wholesale energy markets, and hydro conditions.
- Portfolio analysis was conducted across 351 potential futures, defined by the range of resource needs, technology costs, and wholesale electricity market prices



Ch 5: GHG emissions forecasting

- Chapter 5. GHG emissions forecasting
  - 5.1 HB 2021 targets
  - 5.2 Annual ODEQ reporting process
    - 5.2.1 Specified sources
    - 5.2.2 Unspecified sources
    - 5.2.3 Third-party verification of annual emissions
  - 5.3 Components of IRP emissions reporting
    - 5.3.1 Intermediary GHG model
    - 5.3.2 ODEQ review of PGE forecasted emissions accounting

Chapter highlights

- House Bill 2021 sets 2030, 2035, and 2040 greenhouse gas (GHG) targets for energy used to serve PGE retail load of 1.62, 0.81, and zero million metric tons of GHG emissions, respectively.
- PGE reports its emissions to the ODEQ annually, and those reported emissions will be the basis for determining compliance with HB 2021.
- New for the 2023 IRP, PGE uses an intermediary GHG model to account for differences in regulation of GHG emissions associated with serving retail load and wholesale market sales.
- The IRP studies five different glidepaths for GHG reductions. Actual emissions will likely differ from those predicted here due to weather, resource procurement realities, and other factors.

Ch 6: Resource needs

- Chapter 6. Resource needs
  - 6.1 Load forecast
    - 6.1.1 Top-down econometric load forecasting
    - 6.1.2 Load trends
    - 6.1.3 Load uncertainty
  - 6.2 Distributed Energy Resource (DER) impact on load
    - 6.2.1 Passive DERs
    - 6.2.2 Demand response
    - 6.2.3 Energy efficiency
  - 6.3 Load scenarios
  - 6.4 Existing and contracted resources
  - 6.5 Energy need
    - 6.5.1 Energy-load resource balance
  - 6.6 Capacity need
    - 6.6.1 Capacity under different Need Futures
  - 6.7 RPS need
  - 6.8 Flexibility adequacy
    - 6.8.1 Study takeaways and implications
    - 6.8.2 Future improvements/limitations of current data and analysis
  - 6.9 Climate adaptation
    - 6.9.1 Climate change in the 2023 IRP Reference Case
    - 6.9.2 Temperature years in the 2023 IRP adequacy model
    - 6.9.3 Hydropower climate change data sensitivities
  - 6.10 Need sensitivities
    - 6.10.1 Qualifying facility sensitivities
    - 6.10.2 Accelerated load growth sensitivity
    - 6.10.3 Contract extension sensitivity
    - 6.10.4 Market emissions rate sensitivity
    - 6.10.5 Colstrip sensitivity

Chapter highlights

- Load growth, expiring non-GHG emitting resource contracts, and decreasing retail sales from existing thermal resources drive the need for more non-GHG emitting resources through the planning horizon.
- The load forecast has increased since the 2019 Integrated Resource Plan (IRP) Update due primarily to higher industrial load growth projections. In addition, the persistent impacts of COVID-19 have increased residential usage.
- Distributed energy resources (DERs), including transportation and building electrification, are having a more significant impact on total PGE loads as compared to past IRPs.
- Capacity needs to step upwards in 2026 and grow through the planning horizon due to expiring contracts, exiting resources, and load growth. In the reference case, the 2026 capacity need is 506 MW in the summer and 430 MW in the winter.
- Flexibility needs in 2026 are estimated at 80 MW in the reference case, growing to 122 MW in 2030.
- Although capacity needs increase in both summer and winter throughout the planning horizon, climate change drives relatively more need in the summer and less need in the winter.

Ch 7: Community Benefits Indicators and Community-based Renewable Energy

Chapter 7. Community Benefits Indicators and Community-based Renewable Energy
- 7.1 Community benefits indicators
  - 7.1.1 Defining CBIs
  - 7.1.2 Community benefits indicators pathways
  - 7.1.3 Resource community benefits indicators
  - 7.1.4 Portfolio community benefits indicators
  - 7.1.5 DSP community targeting assessment
  - 7.1.6 Informational community benefits indicators
- 7.2 Community-based renewable energy (CBRE)
- 7.3 Looking ahead
  - 7.3.1 CBIs
  - 7.3.2 CBREs

Chapter highlights

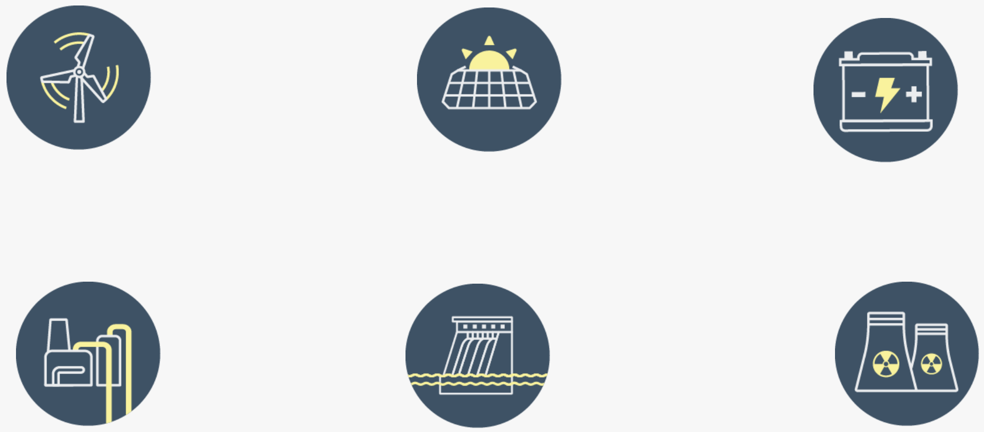
- PGE's Community Lens Potential study defines our approach to the community-based renewable energy (CBRE) forecast and identifies 155 MWs of CBRE potential by 2030.
- PGE's approach to community benefits indicators (CBI) within our Integrated Resource Plan (IRP) is to use a 10% adder for our Resource CBI pathway and a scoring methodology for our Portfolio CBI pathway.
- PGE is committed to evolving our approach to CBIs and CBREs through our Learning Labs as well as through working with our communities to identify future CBRE opportunities through our Community RFP and NWS.

Ch 8: Resource options

- Chapter 8. Resource options
  - 8.1 Utility-scale energy resources
    - 8.1.1 Summary of technologies
    - 8.1.2 Sources of information
    - 8.1.3 Renewable energy generation
    - 8.1.4 Wind and solar weather data
    - 8.1.5 Methodology for average year Capacity Factor
    - 8.1.6 Treatment of tax credits
    - 8.1.7 Renewable generation resources
    - 8.1.8 Energy storage resources
    - 8.1.9 GHG emitting resources
  - 8.2 Additional distributed energy resources
    - 8.2.1 Additional energy efficiency
    - 8.2.2 Additional demand response
  - 8.3 Community-based renewable energy resources
    - 8.3.1 Community-scale standalone solar
    - 8.3.2 Community resiliency microgrid
    - 8.3.3 In-conduit hydropower
  - 8.4 Virtual Power Plant (VPP)
  - 8.5 Post-2030 resource options
    - 8.5.1 Hydrogen and ammonia
    - 8.5.2 Nuclear
    - 8.5.3 Geothermal
    - 8.5.4 Renewable natural gas
    - 8.5.5 Long-duration energy storage
    - 8.5.6 Carbon capture, utilization, and storage
    - 8.5.7 Regional integration
    - 8.5.8 Coastal generation
  - 8.6 Utility versus third-party ownership
    - 8.6.1 Benefits of utility resource ownership
    - 8.6.2 Risks of utility resource ownership
    - 8.6.3 Benefits of third-party ownership
    - 8.6.4 Risks of third-party ownership
    - 8.6.5 Resource ownership considerations

Chapter highlights

- PGE discusses utility-scale supply-side options available for meeting portfolio needs, including wind, solar photovoltaic, and energy storage resources, among others.
- The costs and MW potential of additional energy efficiency and demand response are included as resource options in this IRP.
- An analysis showing the adequacy challenges of a decarbonized system based on current resource options, followed by potential long-term resource options and strategies that can help address the challenges.
- A discussion of the benefits and risks of different resource ownership structures for customers is included.



Ch 9: Transmission

- Chapter 9. Transmission
  - 9.1 Introduction to transmission environment and impact on resource strategy
    - 9.1.1 PGE transmission to serve load
  - 9.2 Regulatory environment
    - 9.2.1 FERC transmission planning notice of public rulemaking
    - 9.2.2 PGE transmission system reliability planning requirements
    - 9.2.3 Regional transmission planning in advance of 2040
  - 9.3 PGE transmission rights and regional environment
    - 9.3.1 The Pacific Northwest transmission system
    - 9.3.2 Regional transmission resources are largely constrained
    - 9.3.3 Regional transmission service request process
    - 9.3.4 PGE merchant transmission portfolio
  - 9.4 Options to address transmission need
    - 9.4.1 Proxy transmission options identify transmission need
    - 9.4.2 Other transmission options
    - 9.4.3 Bethel to Round Butte upgrade for future load service

Chapter highlights

- Portland General Electric's (PGE) unique footprint necessitates collaborative planning with Bonneville Power Administration (BPA) and regional peers to deliver resources to PGE's service area and to serve load within PGE's footprint. Transmission planning and development often takes longer than the Integrated Resource Plan (IRP) action window time horizon, necessitating early proactive efforts.
- As PGE plans to meet House Bill (HB) 2021's decarbonization targets, it is necessary to proactively mitigate transmission constraints to ensure reliable service of current and future load.
- Portfolio analysis in this IRP indicates additional transmission need on PGE's system, across BPA's system, and in additional climate zones.
- PGE proposes addressing transmission need through a combination of rights and/or projects to alleviate congestion across the South of Allston flowgate, expanding transmission to reach additional climate zones that provide resource diversity, and increasing PGE's ability to import electricity through the study of upgrading the Bethel to Round Butte line from 230 to 500 kV.

Ch 10: Resource economics

- Chapter 10. Resource economics
  - 10.1 Fixed costs
  - 10.2 Variable costs
  - 10.3 Flexibility value and integration cost
  - 10.4 Energy value
  - 10.5 Resource capacity contribution
  - 10.6 Capacity value
  - 10.7 Cost of clean energy
  - 10.8 Resource net cost
    - 10.8.1 Net cost of capacity resources
    - 10.8.2 Net cost of energy resources
  - 10.9 Resource community benefits indicators

Chapter highlights

- Resource costs are primarily a function of fixed costs in the current planning environment
- With different resources providing disparate benefits, such as providing energy benefits and storage providing capacity benefits, resource competition is evolving within those two categories
- The inclusion of non-cost-effective Distributed Energy Resources (DER) provides insight into how their role can be further magnified in a decarbonized future
- The relative costs and benefits of different energy and capacity resources that will form the basis for resource selections in portfolio analysis are displayed

Ch 11: Portfolio analysis

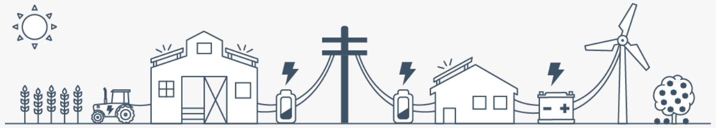
- Chapter 11. Portfolio analysis
  - 11.1 Portfolio design requirements
    - 11.1.1 GHG emissions
    - 11.1.2 Resource adequacy
    - 11.1.3 Generic Resources
    - 11.1.4 Renewable portfolio standards
    - 11.1.5 Energy position
    - 11.1.6 Procurement constraints
    - 11.1.7 Transmission constraints
  - 11.2 Portfolio scoring
  - 11.3 Yearly price impacts
  - 11.4 Portfolio analysis results
    - 11.4.1 Decarbonization glidepath portfolios
    - 11.4.2 Transmission portfolios
    - 11.4.3 Community Based Renewable Energy (CBRE) portfolios
    - 11.4.4 Energy efficiency and demand response portfolios
    - 11.4.5 Optimized portfolios
    - 11.4.6 Targeted policy portfolios
    - 11.4.7 Emerging technology portfolios
  - 11.5 Preferred portfolio
    - 11.5.1 Preferred portfolio yearly price impacts
    - 11.5.2 Resulting RPS position
    - 11.5.3 Resource buildout robustness analysis
  - 11.6 Informational community benefit indicators
  - 11.7 Sensitivities
    - 11.7.1 RFP size
    - 11.7.2 Supply chain

Chapter highlights

- Portfolios are designed to meet emission reduction targets, adequacy needs, transmission, and procurement constraints and are solved across all 378 permutations of price futures, need futures, and technology cost futures
- Portfolio analysis provides insight on the need for transmission, the cost and risk implications of different greenhouse gas (GHG) glidepaths, community-based renewable energy resources (CBREs), and the role for additional DERs in a decarbonized future.
- The insights from these analyses form the basis of the creation of the Preferred Portfolio.
- The Preferred Portfolio represents the combination and timing of resources that best balance costs, risk, emission reductions, and community benefits for customers under the assumptions used in the IRP process.

Ch 12: Action Plan

Chapter 12. Action Plan
- 12.1 Key components of the preferred portfolio
  - 12.1.1 Customer resource additions
  - 12.1.2 Community-based renewable energy additions
  - 12.1.3 Energy additions
  - 12.1.4 Capacity additions
  - 12.1.5 Transmission expansion
- 12.2 Action plan
  - 12.2.1 Customer resource action
  - 12.2.2 CBRE action
  - 12.2.3 Energy action
  - 12.2.4 Capacity action
  - 12.2.5 Transmission expansion action
- 12.3 Request for Proposals
- 12.4 Conclusion



Chapter highlights

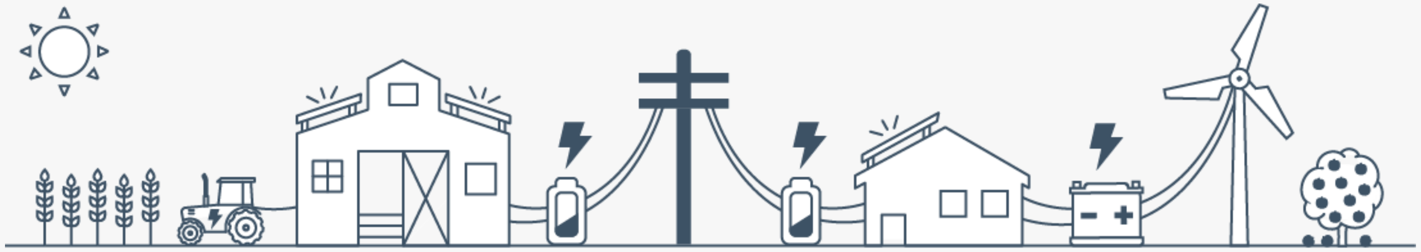
- PGE's Action Plan proposes a set of resource actions that we intend to take over the next four years.
- The Action Plan is built on the results of the five key components of the Preferred Portfolio that meet long-term system needs and decarbonization targets while minimizing cost and risk and maximizing community benefits.
- Customer resource actions include acquiring forecasted quantities of 'cost-effective' energy efficiency and demand response.
- The pursuit of Community-Based Renewable Energy (CBRE) resources is a cost-effective way to maximize community benefits.
- The energy action initiates a Request for Proposals (RFP) for non-GHG-emitting energy resources targeting one fifth of the remaining energy need after the addition of EE and CBRE resources.
- A capacity action targets the remaining resource adequacy needs in 2026 after contributions from CBRE and other energy resources as well as bilateral contracts.
- PGE will pursue all options to mitigate congestion on the South of Alston flowgate
- The Bethel-Round Butte transmission provides the best alleviation of near-term transmission constraints.

Ch 13: Resilience

- Chapter 13. Resilience
  - 13.1 Resilience overview
  - 13.2 Evaluating resilience risks
    - 13.2.1 Natural disaster risk assessment methodology
    - 13.2.2 Climate change vulnerability assessment
    - 13.2.3 Reliability metrics
    - 13.2.4 Community resilience index
  - 13.3 Zone of tolerance
    - 13.3.1 Energy equity index development
    - 13.3.2 Justice 40 initiative
    - 13.3.3 Critical Customer Program (CCP)
    - 13.3.4 Medical Certificate Program
    - 13.3.5 Heat vulnerability data
  - 13.4 Historical reliability data
  - 13.5 Programs and opportunities
    - 13.5.1 Resilience in other plans
    - 13.5.2 CBRE potential study
    - 13.5.3 EPRI Climate READi: Power resilience and adaptation initiative
    - 13.5.4 VOS study update
    - 13.5.5 Smart battery pilot
    - 13.5.6 Energy partner on-demand
    - 13.5.7 Energy partner resilience (dispatchable standby generation)
    - 13.5.8 Multi-unit microgrid demonstration- Salem smart power center
    - 13.5.9 Community resilience hubs
    - 13.5.10 Portable storage pilot
    - 13.5.11 Public safety partner engagement program
  - 13.6 Looking ahead

Chapter highlights

- PGE used existing risk assessment analysis regarding system and customer resilience, including energy equity work conducted through PGE's Distribution System Plan (DSP).
- PGE's Annual Report provides historical reliability data and is the best place to add new reliability metrics required through the Clean Energy Plan (CEP).
- PGE identifies datasets and approaches to the zone of tolerance analysis.
- PGE's current and potential resilience programs and opportunities are needed to anticipate, adapt to, withstand, and quickly recover from disruptive events.

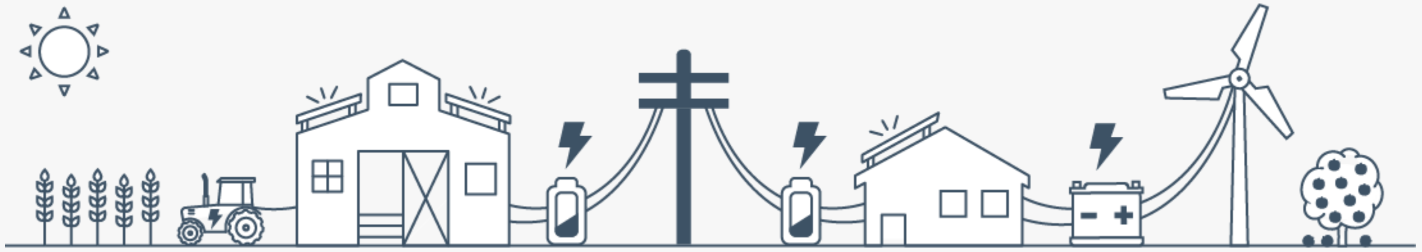


Ch 14: Community equity lens

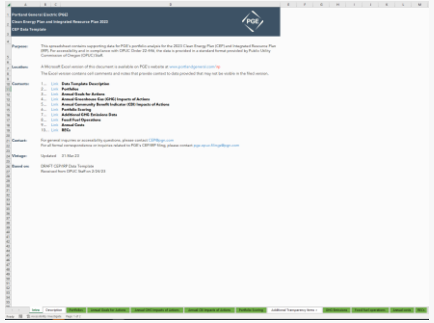
Chapter 14. Community equity lens
- 14.1 Community equity lens overview
- 14.2 Clean energy transition
  - 14.2.1 Importance of equity and human-centered approach
- 14.3 Community engagement
  - 14.3.1 Community Benefits Impact Advisory Committee
  - 14.3.2 Tribal engagement
  - 14.3.3 Community learning labs
  - 14.3.4 Roundtables
  - 14.3.5 Community surveys and feedback
  - 14.3.6 Relationship building & informal engagement
  - 14.3.7 OPUC public meeting and advocate feedback
  - 14.3.8 Transparency and accessibility
  - 14.3.9 Effectiveness of community engagement
- 14.4 Continuing community engagement

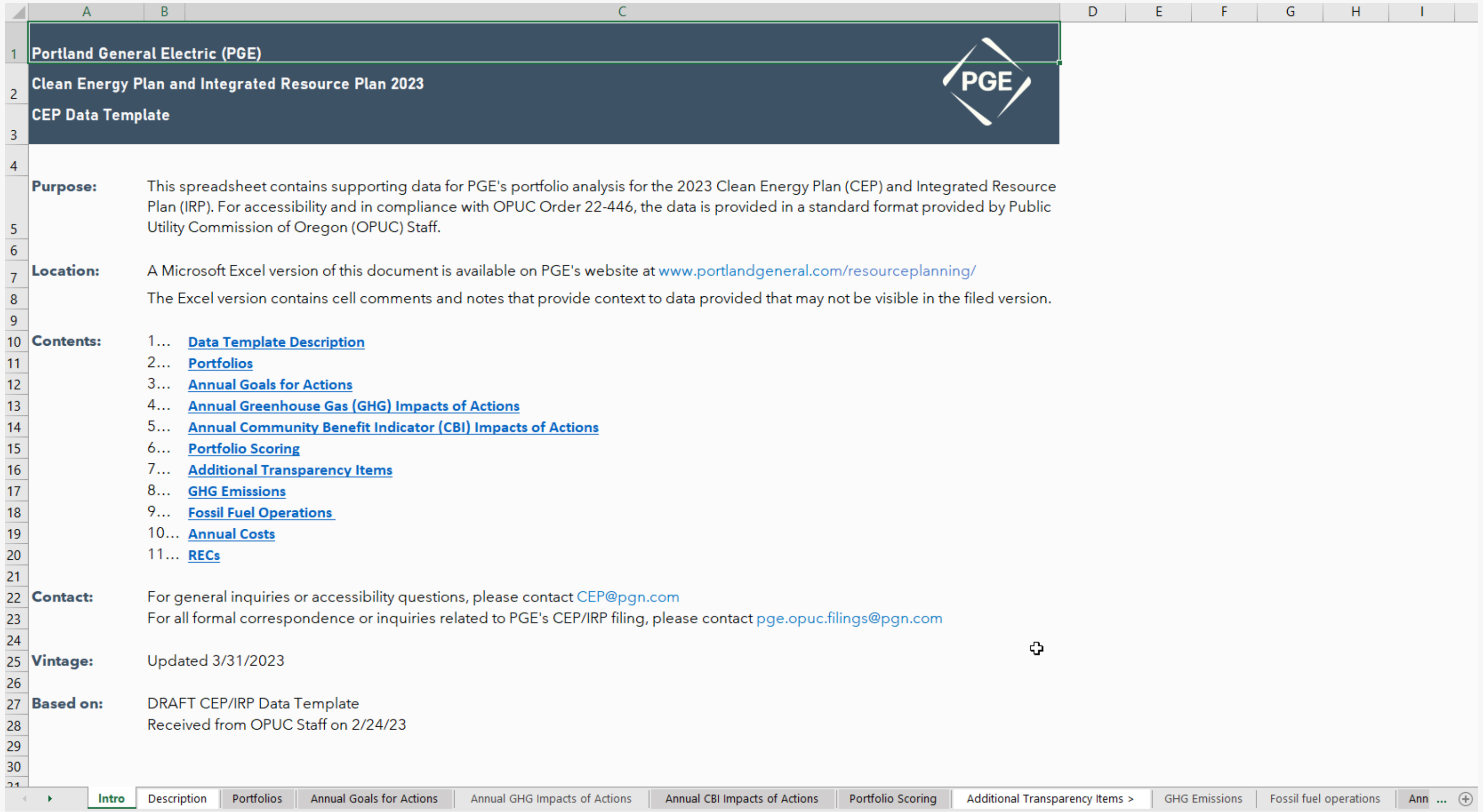
Chapter highlights

- PGE's community engagement strategy and goals for PGE's long-term planning processes build on our experiences with the DSP.
- As part of our planning process, PGE sought input from non-traditional stakeholders, including individuals and organizations representing environmental justice communities. Our engagement strategy aligned multiple channels such as our Learning Labs, Roundtables, relationship building and surveys.
- PGE sought to deploy and iterate accessible opportunities to gather feedback, including Mural Boarding and surveys.
- We are tracking the input we received through Mural and using it to inform continuing planning and resource acquisition activities related to the CEP/IRP process.



CEP Data Template





Portland General Electric (PGE)
Clean Energy Plan and Integrated Resource Plan 2023
CEP Data Template

Purpose: This spreadsheet contains supporting data for PGE's portfolio analysis for the 2023 Clean Energy Plan (CEP) and Integrated Resource Plan (IRP). For accessibility and in compliance with OPUC Order 22-446, the data is provided in a standard format provided by Public Utility Commission of Oregon (OPUC) Staff.

Location: A Microsoft Excel version of this document is available on PGE's website at www.portlandgeneral.com/resourceplanning/

The Excel version contains cell comments and notes that provide context to data provided that may not be visible in the filed version.

Contents:

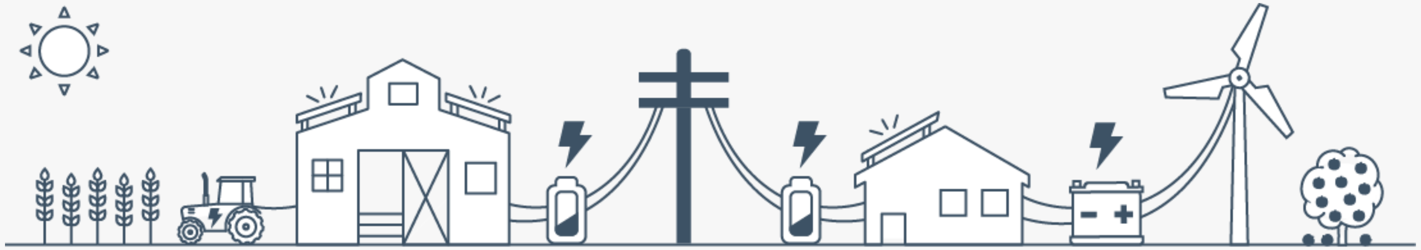
1… Data Template Description
2… Portfolios
3… Annual Goals for Actions
4… Annual Greenhouse Gas (GHG) Impacts of Actions
5… Annual Community Benefit Indicator (CBI) Impacts of Actions
6… Portfolio Scoring
7… Additional Transparency Items
8… GHG Emissions
9… Fossil Fuel Operations
10… Annual Costs
11… RECs

Contact: For general inquiries or accessibility questions, please contact CEP@pgn.com
For all formal correspondence or inquiries related to PGE's CEP/IRP filing, please contact pge.opuc.filings@pgn.com

Vintage: Updated 3/31/2023

Based on: DRAFT CEP/IRP Data Template
Received from OPUC Staff on 2/24/23

Intro | Description | Portfolios | Annual Goals for Actions | Annual GHG Impacts of Actions | Annual CBI Impacts of Actions | Portfolio Scoring | Additional Transparency Items > | GHG Emissions | Fossil fuel operations | Ann …



IRP Limitations and Areas for Improvement

NIHIT SHAH, TOMAS MORRISSEY, ROB CAMPBELL, PGE





PGE An Oregon kind of energy.[SM]

In this section, we will:

- Highlight key limitations of IRP analysis
- Propose areas of improvement for future IRP modeling that need to be addressed to reflect the newer planning environment
- Highlight key assumptions that could impact resource actions

Resource adequacy

Improve the dispatch logic of demand response resources

Currently DR resources enter Sequoia as a fixed shape. In the future we would like resources to be modeled as a dispatchable resource.

Improve long duration storage modeling

Sequoia runs on a weekly timestep, making the evaluation of long duration / seasonal storage challenging

Improve modeling of transmissions impact on resource adequacy

Continue to study how to best model conditional firm Tx. Current approach is to curtail top 100 load hours to proxy CF 200 Tx.

Evaluate demand and generation correlations

Sequoia uses five load bins to capture these correlations, more work is needed to understand how this modeling choice drives results

Resource adequacy (2)

Integrate some of the WRAP's methods, outputs, and data within IRP resource adequacy

As the WRAP matures, we will look for ways to align IRP adequacy to the WRAP.

Improve modeling of spot market availability for resource adequacy

Look for more data sources/methods for estimating regional adequacy needs beyond the Power Council's Power Plan data inputs. This could potentially use data from the WRAP.

Improve modeling of resource integration

Do we need to change our reserve needs as we see more variable energy resources on the system?

Understand the need for and the ability to estimate sub-hourly flexibility needs

We currently look at flexibility at an hourly level, will investigate data/model needs to look sub-hourly.

Flexibility assessment – Sub hourly modeling

Flexibility adequacy is an element of resource adequacy highlighting the deficit in a system's operational capabilities

In this IRP we evaluated flexibility adequacy on an hourly basis. As intermittent resources increase, they need to be balanced at the sub-hourly level

Sub-hourly flexibility needs, or resource integration impacts is a growing body of research. PGE is in the learning phase and will continue to focus on this topic

Some questions to be addressed

- Is there sufficiently granular data of a future system to perform this analysis within resource planning?
- Is there an industry standard or accepted modeling practices to perform such an assessment?
- How do we apply annual reliability targets and standards to a sub-hourly analysis?
- How do we account for the interaction between the different adequacy analyses, ensuring that the needs are not under or over-represented?

Granularity of energy accounting in portfolio analysis

2023 IRP – Annual accounting

- Annual granularity does not allow for accounting of seasonal variation in load and energy generation profiles
- Can ensure sufficient energy for each whole year
- Cannot ensure sufficient energy throughout the course of each year

Future Improvements

- Increase granularity of energy load resource balance from annual to monthly
- Monthly granularity can improve matching of timing of energy generation with energy needs
- Increased granularity will inform resource buildout in ROSE-E

Transmission resource options in portfolio analysis

2023 IRP

3 proxy transmission resource options:

- 1 Transmission upgrade option
- 2 Transmission expansion options

Future Improvements

Increase number of proxy transmission options

- Tx lines to more locations
- Model multiple resources on different potential transmission lines

Costs and benefits of transmission in portfolio analysis

2023 IRP

- Generic publicly available cost information used to derive cost estimates for all proxies
- Benefits assume market access provides perfect capacity

Future Improvements

- Increase detail of cost estimates to more closely match characteristics of proxy options to distinguish between options
- Model alternative levels of benefits provided by transmission expansion

Modeling of transmission constraints in portfolio analysis

2023 IRP

- BPA transmission capacity derived from review of TSRs in TSEP reports
- First attempt at building constraints into ROSE-E

Future Improvements

- Review and refresh estimates of available capacity
- Increase sophistication of modeling methodology in ROSE-E

IRP – Global limitations, assumptions, and areas for improvement

Avoided cost limitations and areas for improvement

- Using publicly available NREL cost data to set avoided costs can result in mismatch in market incentives
- Using 1 year of avoided costs for capacity can lead to mismatches in long-term resource valuation in capacity
- Incorporating the cost of clean energy

Tax credit assumptions and areas of improvement

- Study impacts of taxes and grants on proxy resources and emerging technologies

Distribution connected resources areas of improvement

- Understanding type of CBRE projects, their cost, timing, and the resulting community benefit
- Improved data integration and quality control between IRP, CEP, DSP, and Energy Trust

IRP –Global limitations, assumptions, and areas for improvement

Regional market impacts

- Impacts of regional markets once fully defined and established
- Continue to review regional resource additions and their impact on regional prices and adequacy
- Continue to review regional transmission upgrades and new builds, which can provide opportunities to address long-term needs

Emerging technologies

Improve understanding of emerging technology costs, lead time, operating characteristics, and feasibility

PGE's 2022 UM 1728 Order

KORI MEAD, PGE

ROUNDTABLE 23-3

UM 1728

Order No 21-215 detailed the Commission's approval of PGE's update to Schedule 201 avoided cost payments to Qualifying Facilities (QF). Per Attachment A to Staff's Report, PGE agreed to present certain analyses in an IRP Roundtable Meeting.

PGE presented materials related to Order No. 21-125 at the March 10, 2022, IRP Roundtable Meeting.

PGE reviewed information for both PacifiCorp and Idaho Power from certain non-confidential data request responses from dockets LC 77 and LC 78 to "review the historic percentage of QFs reaching completion and renewals for other utilities."

This presentation contains PGE's review of certain information that pertains to other utilities, but PGE makes no claims or assertions that this information is complete or accurate. PGE cannot provide any additional details regarding this information other than the overview of the review PGE conducted in this presentation.

QF Projects that Failed to Achieve Commercial Operation

Idaho Power[2]	Total Projects Contracted	Projects that did not achieve Commercial Operation (CO)	Failure Rate
Total MW	2,161	853	39%
Total Projects	204	48	24%

PacifiCorp[2]	Total Projects Contracted	Projects that did not achieve Commercial Operation (CO)	Failure Rate
Total MW	2,934	621	21%
Total Projects	195	21	11%

PGE[1]	Total Projects Contracted	Projects that did not achieve Commercial Operation (CO)	Failure Rate
Total MW	723	418	58%
Total Projects	137	69	50%

Technology	Idaho Power	PacifiCorp	PGE
Biomass	7	-	3
Geothermal	1	1	-
Hydro	2	1	-
Solar	16	6	63
Wind	22	11	2
Methane	-	1	1
Natural Gas	-	1	0
Total	**48**	**21**	**69**

[1] PGE QF data used throughout presentation is based on QF snapshot used in previous roundtable presentation in March 2022
[2] QF data used throughout this presentation is as of Q3 2022

Idaho and PacifiCorp Projects by State

There are vastly different conditions for QFs across all of these states and within Oregon including, but not limited to - QF contracting process, avoided cost prices, standard QF terms and conditions, very diverse interconnection processes, transmission constraints, and mix of on-system and off-system projects. Thus, any utility comparison is not particularly meaningful. At a minimum, it is not appropriate to compare PGE's QF history to that of PacifiCorp's and Idaho Power's entire QF queue but should be reviewed for their specific history in Oregon.

Idaho Power	Total Projects Contracted	Total MW	% of Total
Idaho	169	1,863	86%
Oregon	35	298	14%
Total	**204**	**2,161**	**100%**

PacifiCorp	Total Projects Contracted	Total MW	% of Total
California	7	20	1%
Idaho	21	196	7%
Oregon	93	609	21%
Utah	46	1,173	40%
Wyoming	5	926	32%
Washington	23	11	0%
Total	**195**	**2,934**	**100%**

Oregon Projects by Technology

PGE holds **over half** of all the QF contracts executed in Oregon, when considering those contracted for by all three utilities.

PGE's history with solar QF in particular is over **five times** that of both other utilities. Although QFs that have signed contracts with PacifiCorp have had more success with their much smaller volume of executed QF contracts, Idaho's success is comparable to PGE given its much small set of QF contracts.

	PacifiCorp				Idaho Power				PGE			
Technology	Total Projects Contracted	% of Total	Failed Project	Failure Rate	Total Projects Contracted	% of Total	Failed Project	Failure Rate	Total Projects Contracted	% of Total	Failed Project	Failure Rate
Biomass	5	5%	-	0%	1	3%	-	0%	4	3%	3	75%
Geothermal	3	3%	1	33%	-	-	-	0%	1	1%	-	0%
Methane	7	8%	1	14%	-	-	-	0%	-	-	-	-
Natural Gas	2	2%	-	0%	-	-	-	0%	-	-	-	-
Solar	26[1]	28%	4	15%	23[2]	66%	9	39%	139[3]	90%	63	45%
Hydro	29	31%	1	3%	5	14%	-	0%	5	3%	-	-
Wind	21	23%	5	29%	6	17%	-	0%	3	2%	2	67%
Biogas	-	-	-	-	-	-	-	-	3	2%	1	33%
Total	93	100%	13	14%	35	100%	9	26%	155	100%	69	45%

[1] Success in not yet known on 2 projects that had not reached their expected commercial operation as of the date of this data. If the 2 projects who have not yet achieved commercial operation are excluded, the total failure rate for solar is **25%.**

[2] Success in not yet known on 3 projects that had not reached their expected commercial operation as of the date of this data. If the 3 projects who have not yet achieved commercial operation are excluded, the total failure rate for solar is **45%.**

[3] Success in not yet known on 18 projects that had not reached their expected commercial operation as of the date of this data. If the 18 projects who have not yet achieved commercial operation are excluded, the total failure rate for solar is **51%.**

Oregon Projects by Technology

PGE holds **over half** of all the QF contracts executed in Oregon, when considering those contracted for by all three utilities.

PGE's history with solar QF in particular is over **five times** that of both other utilities. Although QFs that have signed contracts with PacifiCorp have had more success with their much smaller volume of executed QF contracts, Idaho's success is comparable to PGE given its much small set of QF contracts.

	PacifiCorp				Idaho Power				PGE			
Technology	Total MW	% of Total	Failed MW	Failure Rate	Total MW	% of Total	Failed MW	Failure Rate	Total Projects Contracted	% of Total	Failed Project	Failure Rate
Biomass	70	12%	-	0%	10	3%	-	0%	58	5%	48	83%
Geothermal	14	3%	10	71%	-	-	-	0%	10	1%	-	0%
Methane	15	2%	3	20%	-	-	-	0%	-	-	-	-
Natural Gas	1	2%	-	0%	-	-	-	0%	-	-	-	-
Solar	261[1]	43%	37	14%	220[2]	74%	69	31%	970[3]	89%	348	36%
Hydro	55	9%	10	18%	15	5%	-	0%	7	1%	-	-
Wind	182	30%	60	33%	53	18%	-	0%	29	3%	20	69%
Biogas	-	-	-	-	-	-	-	-	13	1%	2	19%
Total	609	100%	120	20%	298	100%	69	23%	1,087	100%	418	39%

[1] Success in not yet known on 58MW that had not reached their expected commercial operation as of the date of this data. If the 2 projects who have not yet achieved commercial operation are excluded, the total failure rate for solar is **18%.**

[2] Success in not yet known on 74MW that had not reached their expected commercial operation as of the date of this data. If the 3 projects who have not yet achieved commercial operation are excluded, the total failure rate for solar is **48%.**

[3] Success in not yet known on 365MW that had not reached their expected commercial operation as of the date of this data. If the 18 projects who have not yet achieved commercial operation are excluded, the total failure rate for solar is **48%.**

Oregon Projects by Expected COD Year

Based on expected COD year, PGE has been the contracting utility for **84%** of the contracts since 2018.

	PacifiCorp			Idaho Power			PGE			Total	
Year	Projects by Year	Cumulative Projects	Cumulative as a % of Total	Projects by Year	Cumulative Projects	Cumulative as a % of Total	Projects by Year	Cumulative Projects	Cumulative as a % of Total	Total Projects	Total Cumulative Projects
1982	1	1	1%	0	0	0%	0	0	0%	1	1
1983	2	3	3%	0	0	0%	0	0	0%	2	3
1985	2	5	5%	1	1	3%	0	0	0%	3	6
1986	2	7	8%	0	1	3%	0	0	0%	2	8
1987	2	9	10%	0	1	3%	0	0	0%	2	10
1989	2	11	12%	1	2	6%	0	0	0%	3	13
1993	0	11	12%	1	3	9%	0	0	0%	1	14
2006	1	12	13%	0	3	9%	0	0	0%	1	15
2007	4	16	17%	0	3	9%	0	0	0%	4	19
2008	1	17	18%	0	3	9%	0	0	0%	1	20
2009	12	29	31%	0	3	9%	0	0	0%	12	32
2010	5	34	37%	0	3	9%	0	0	0%	5	37
2011	1	35	38%	3	6	17%	2	2	1%	6	43
2012	9	44	47%	0	6	17%	1	3	2%	10	53
2013	2	46	49%	0	6	17%	2	5	3%	4	57
2014	2	48	52%	0	6	17%	2	7	5%	4	61
2015	2	50	54%	1	7	20%	3	10	6%	6	67
2016	6	56	60%	20	27	77%	3	13	8%	29	96
2017	8	64	69%	0	27	77%	14	27	17%	22	118
2018	15	79	85%	0	27	77%	11	38	25%	26	144
2019	3	82	88%	5	32	91%	67	105	68%	75	219
2020	5	87	94%	0	32	91%	26	131	85%	31	250
2021	1	88	95%	0	32	91%	8	139	90%	9	259
2022	4	92	99%	0	32	91%	9	148	95%	13	272
2023	1	93	100%	2	34	97%	6	154	99%	9	281
2024	0	93	100%	1	35	100%	1	155	100%	2	283
Total	**93**			**35**			**155**			**283**	

QF Contracts that Renewed

Idaho Power	Total Projects that achieved CO	Total Projects that have had expiring contracts	Projects that renewed	Renewal Rate for expiring contracts	Renewal rate for all contracts
Total MW	1,308	76	53	70%	4%
Total Projects	156	44	40	91%	26%

PacifiCorp	Total Projects that achieved CO	Total Projects that have had expiring contracts	Projects that renewed	Renewal Rate for expiring contracts	Renewal rate for all contracts
Total MW	2,313	365	288	79%	12%
Total Projects	174	57	32	56%	18%

PGE[1]	Total Projects that achieved CO	Total Projects that have had expiring contracts	Projects that renewed	Renewal Rate for expiring contracts	Renewal rate for all contracts
Total MW	304	0.49	0.49	100%	0%
Total Projects	68	3	3[1]	100%	4%

[1] All PGE renewals were based on contracts with original terms of 2 years (Domaine Drouhin, Minikahda Hydropower, Von Family Limited Partnership)

Technology	Idaho Power	Pac	PGE
Biomass	2	3	-
Methane	-	1	-
Natural Gas	-	5	-
Waste Heat	-	2	-
Wind	-	2	-
Hydro	37	24	2
Cogen	1	-	-
Solar	-	-	1
Total	**40**	**37**	**3**

Upcoming QF Renewals

PGE does not anticipate any renewals for QFs to occur any earlier than 2027.

PPA End Year	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2042	2043	Total
MW	6	0	0	0	11	77	10	33	93	67	94	265	4	8	669

Questions

NEXT STEPS

A recording from today's webinar will be available in one week

Upcoming Roundtables: N/A

Upcoming IRP Filing Date: March 31, 2023

OPUC Initial Comment Period: initial comments due approx. April 30, 2023 (subject to LC 80 docket schedule)

Thank you

Contact us at
IRP@PGN.COM

An

Oregon

Oregon

Oregon

Oregon

Oregon

Oregon

kind of energy

ACRONYMS

CBI (iCBI, rCBI, pCBI): community benefit indicators

CEP: clean energy plan

ETO: energy trust of Oregon

CBRE: community based renewable energy

RFP: request for proposal

MYP: multi-year plan

DSP: distribution system plan

EJ: environmental justice

EE: energy efficiency

GHG: greenhouse gas

ODOE: Oregon department of energy

CBIAG: community benefits and impacts advisory group

LOLH: loss of load hours

DR: demand response

HB2021: House Bill 2021

MW: megawatt

ELCC: effective load carrying capacity

MWa: mega watt average

kW: kilowatt

RPS: renewable portfolio standard

Tx: Transmission

BPA: Bonneville Power Administration

NCE: non-cost effective

NPVRR: net present value revenue requirement

PSH: pumped storage hydro

NG: natural gas

SoA: South of Allston

REC: renewable energy credit

VPP: virtual power plant

C&I: commercial and industrial

EUI: energy use intensity

NAICS: North American industry classification system

UPS: uninterruptible power supply

ITE: information technology equipment

DC: direct current

WECC: western electricity coordinating council

IE: independent evaluator

LT/ST: long term/ short term

ITC: investment tax credit

T&D: transmission and distribution

PPA: power purchase agreement

RTO: regional transmission organization

RRRR: reference case price future

RLRR: low carbon price future

VER: variable energy resources

PV: photovoltaic

ART: annual revenue-requirement tool

CEC: California energy commission