Integrated Resource Planning

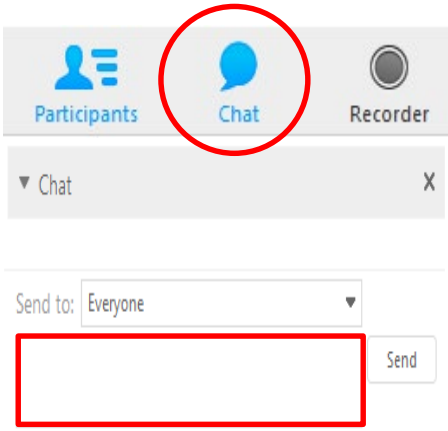
Roundtable #19-2 | May 22, 2019

Meeting Logistics

Participants:

- Ask questions via ‘chat’ feature
- Meeting will stay open during breaks, but will be muted
- Electronic version of presentation: *portlandgeneral.com/irp*

>> Integrated Resource Planning



AGENDA

- Updated Portfolio Analysis
- Updated Preferred Portfolio
  - Near-term resource additions
  - Renewable Glide Path
  - GHG forecast
- 2019 IRP Next Steps

Safety Moment

Water smarts - It only takes a moment. A child or weak swimmer can drown in the time it takes to reply to a text, check a fishing line or apply sunscreen.

- Know your limitations, including physical fitness, medical conditions.
- Never swim alone; swim with lifeguards and/or water watchers present.
- Wear a U.S. Coast Guard-approved life jacket appropriate for your weight and size and the water activity. Always wear a life jacket while boating, regardless of swimming skill.
- Paying close attention to children or weak swimmers you are supervising in or near water.
- Knowing ways to safely assist a drowning person, such as “reach or throw, don’t go”.
- Monitor people for “dry drowning” after a period underwater

https://www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/water-safety.html

2019 IRP Schedule

PGE released the Draft 2019 IRP on May 17th

2019 IRP Process so far

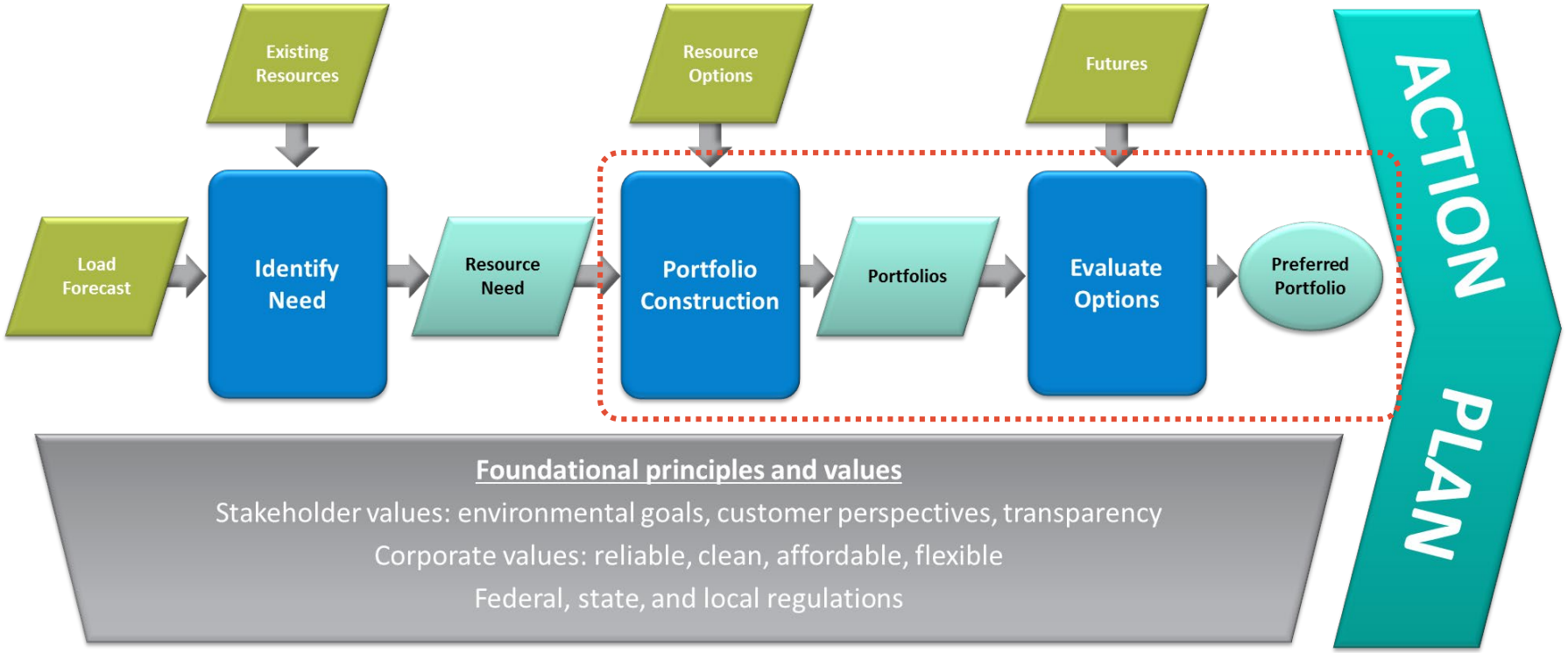
- **Public Roundtable and Technical Meetings**
  - 215 attendees (online and in-person) at eleven public meetings
  - Slides available online: https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning/irp-public-meetings
- **Stakeholder comments and portfolio requests**
  - Over 20 submitted informal comments, 5 submitted portfolio requests
  - All comments will be posted online with the final filed IRP
- **Draft 2019 IRP**
  - Available online: https://www.portlandgeneral.com/-/media/public/our-company/energy-strategy/documents/2019-irp.pdf
  - Released on May 17th, requesting comments by June 17th

Thank you for your continued participation in our process!

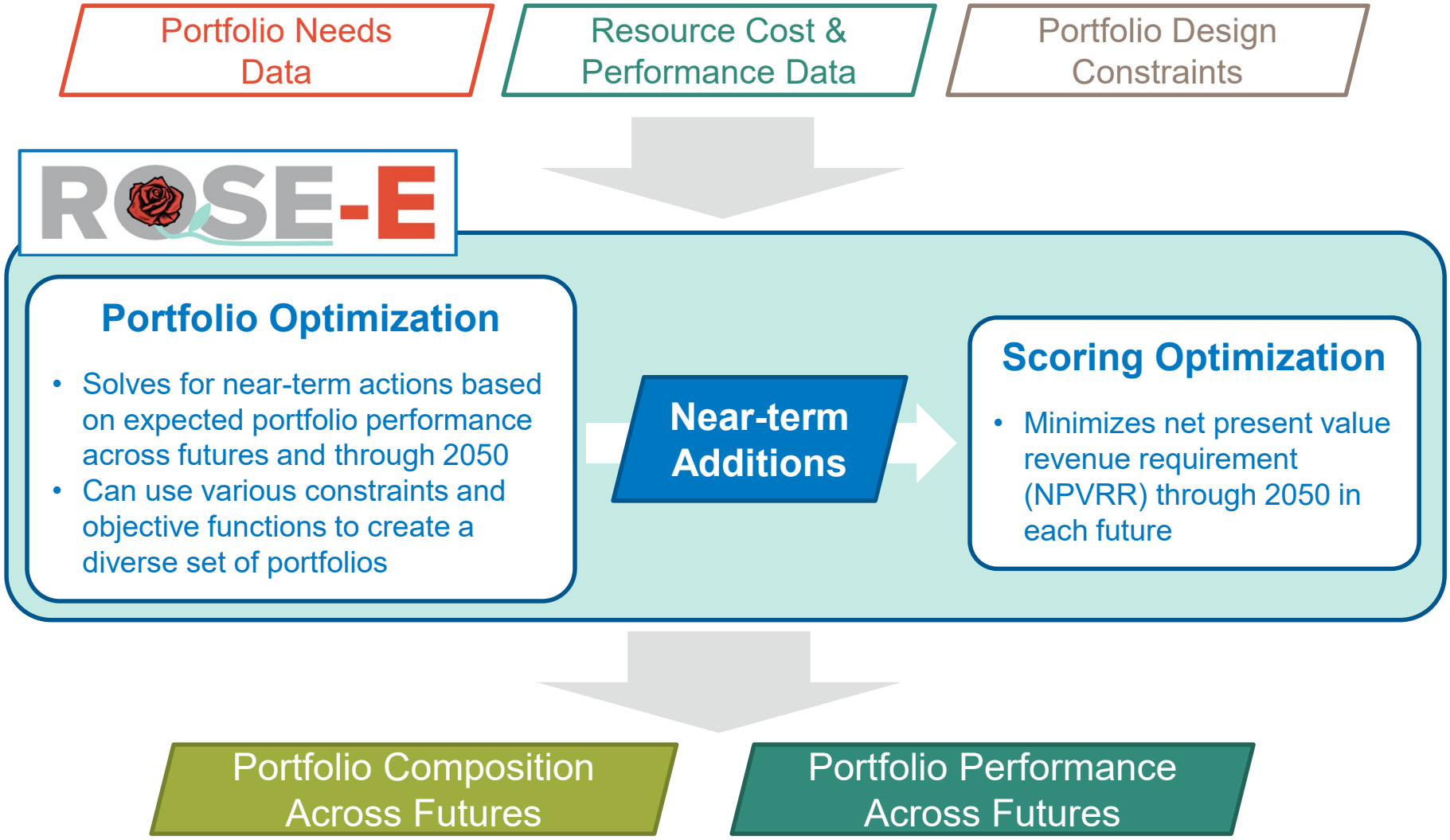
Updated Portfolio Analysis

Elaine Hart

Portfolio Analysis



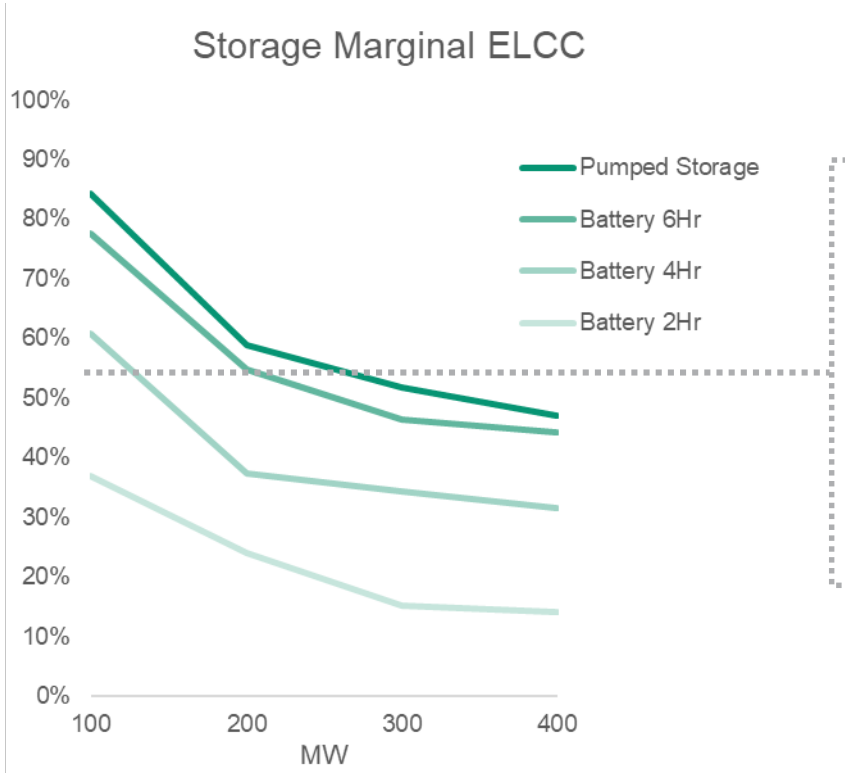
Portfolio Construction Overview



Portfolio Construction Updates

Energy Storage Capacity Contribution

Issue presented at Roundtable #19-1:



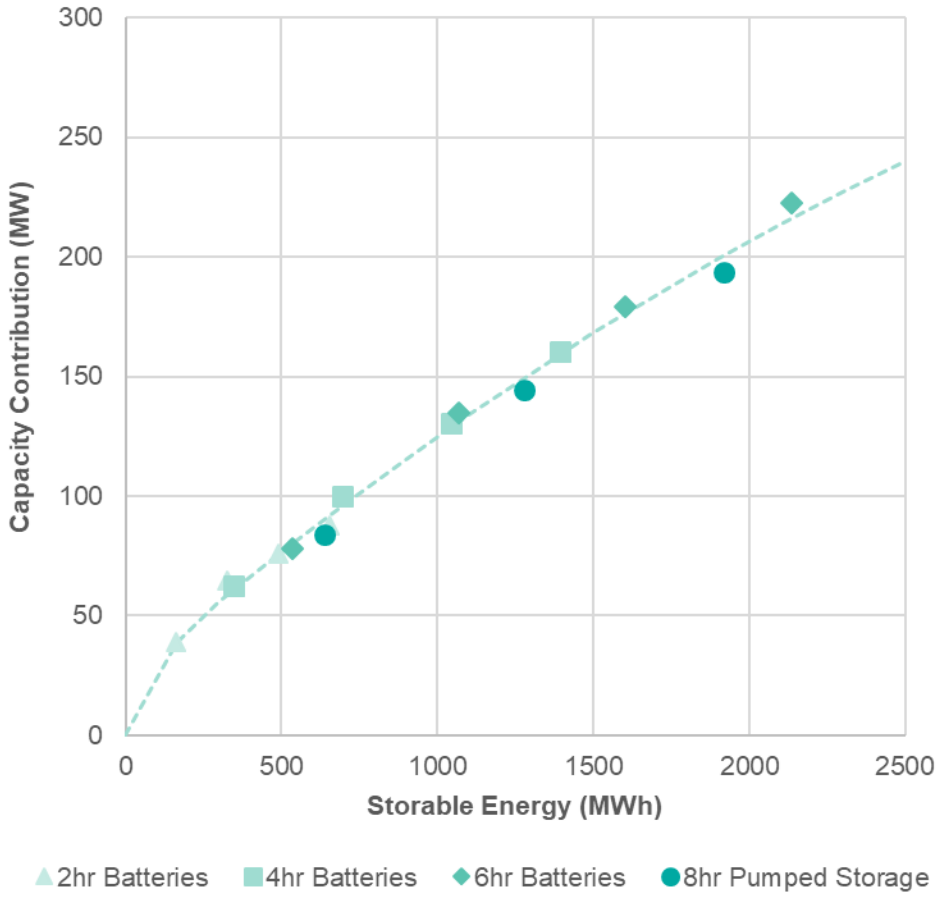
Consider a portfolio that has selected 100 MW of 6-hr batteries

For the next tranche of capacity, 100 MW of 4-hr batteries appears to have a higher capacity contribution than the next 100 MW of 6-hr batteries

Portfolio Construction Updates

Energy Storage Capacity Contribution

- RECAP results revealed trend in capacity contribution across all storage resources
- "Storable Energy" was found to be a good indicator of capacity contribution
  - Storable energy = [Storage capacity (in MWh)] x [Roundtrip efficiency]
- Parameterization based on "storable energy" used in ROSE-E to estimate capacity contribution of entire storage portfolio in each year



Updated Portfolio Results

Portfolios

- Optimized Portfolios
- Renewable Size and Timing Portfolios
- Renewable Resource Portfolios
- Dispatchable Capacity Portfolios

Portfolio Scoring

Preferred Portfolio

Optimized Portfolios

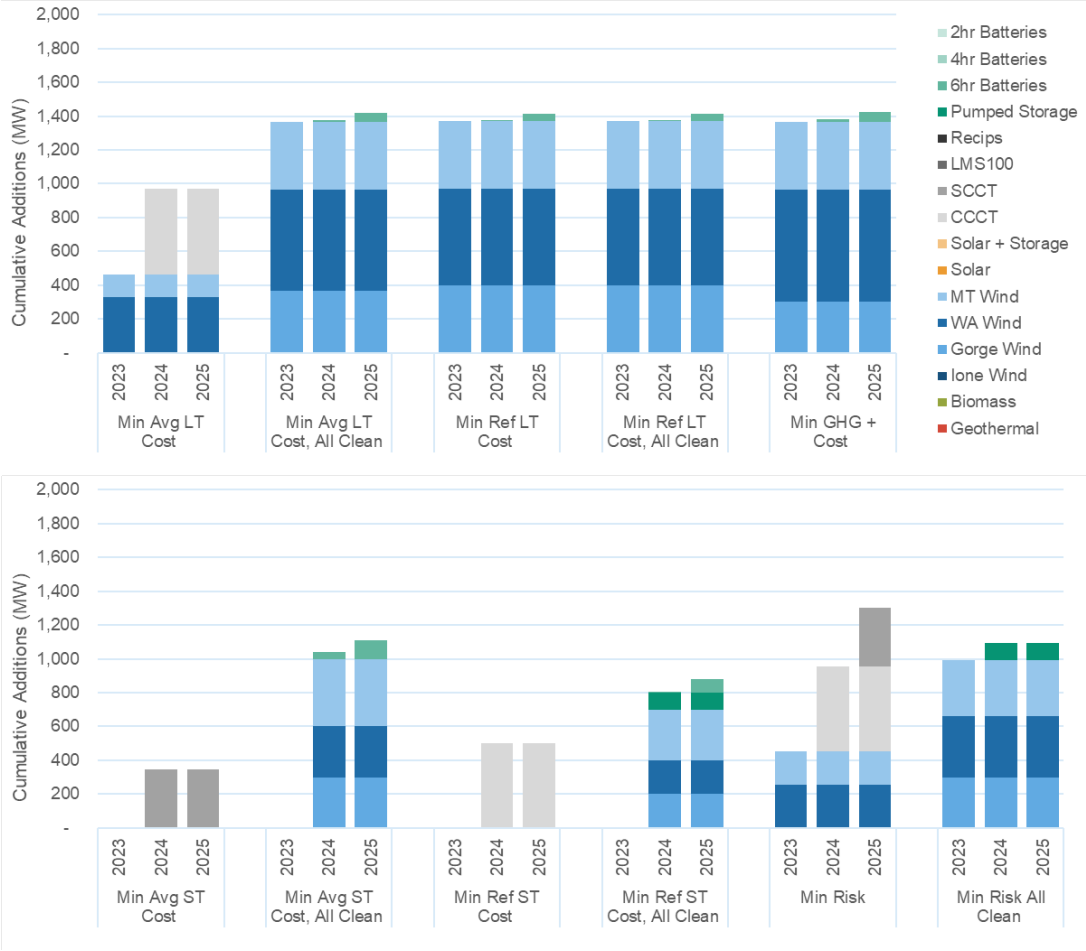
- Utilizes portfolio optimization to design portfolios that meet various objectives and under various constraints

Portfolio	Objective Function	Portfolio Design Constraints
Min Avg LT Cost	Minimizes average long-term (LT) NPVRR through 2050 across futures	None
Min Avg LT Cost, All Clean	Minimizes average NPVRR through 2050 across futures	Excludes GHG-emitting resources
Min Ref LT Cost	Minimizes Reference Case NPVRR through 2050	None
Min Ref LT Cost, All Clean	Minimizes Reference Case NPVRR through 2050	Excludes GHG-emitting resources
Min Avg ST Cost	Minimizes average short-term (ST) NPVRR through 2025 across futures	None
Min Avg ST Cost, All Clean	Minimizes average NPVRR through 2025 across futures	Excludes GHG-emitting resources
Min Ref ST Cost	Minimizes Reference Case NPVRR through 2025	None
Min Ref ST Cost, All Clean	Minimizes Reference Case NPVRR through 2025	Excludes GHG-emitting resources
Min Risk	Minimizes semi-deviation of NPVRR through 2050 across futures	Reference Case NPVRR cannot exceed $25,500 million
Min Risk, All Clean	Minimizes semi-deviation of NPVRR through 2050 across futures	Excludes GHG-emitting resources; Reference Case NPVRR cannot exceed $25,500 million
Min GHG + Cost	Minimizes the sum of the average NPVRR through 2050 across futures and the cumulative emissions across futures	Excludes GHG-emitting resources

All data is draft until filed.

Optimized Portfolios

Utilizes portfolio optimization to design portfolios that meet various objectives



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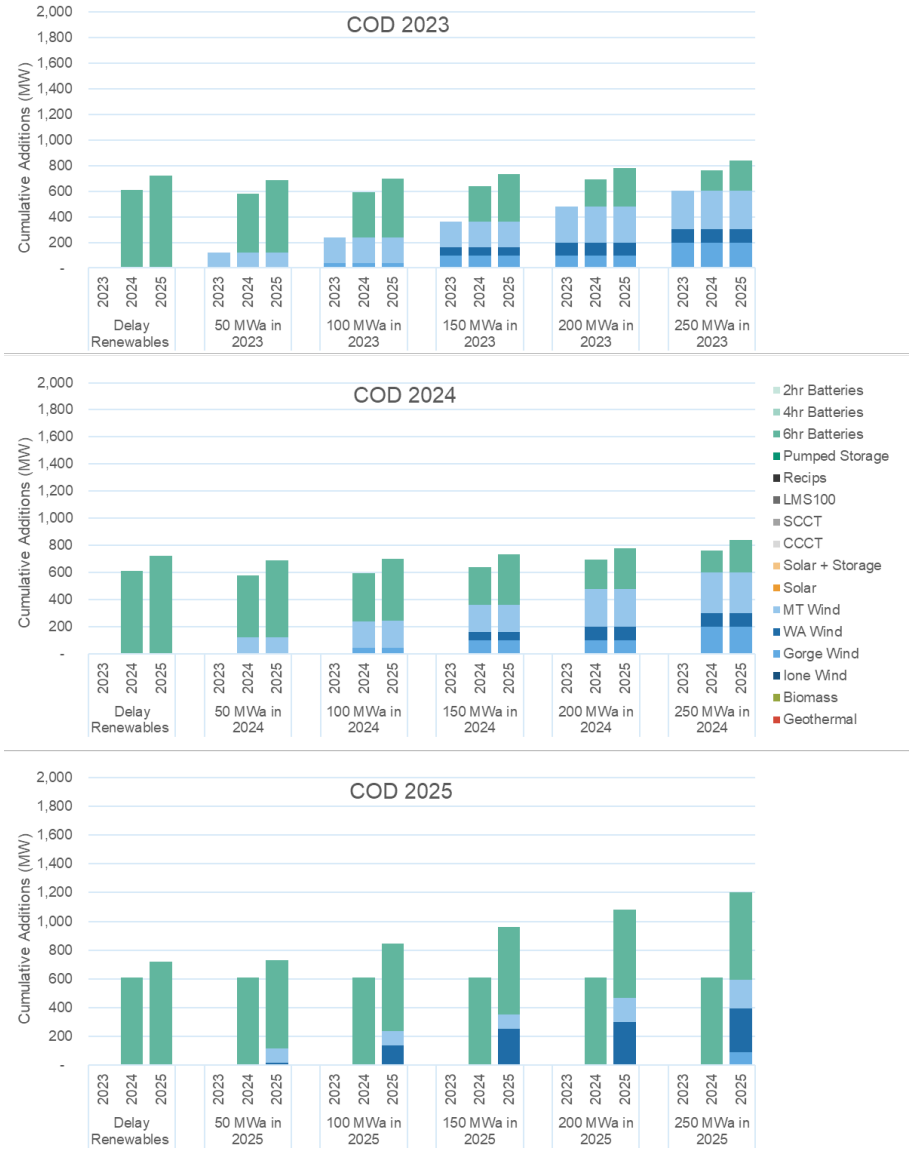
Renewable Size and Timing Portfolios

- Tests renewable resource economics as a function of both procurement size (MWa) and online date (COD)
- These portfolios require a specified amount of RPS-eligible energy to be procured in a specified year, but allow for the optimal selection of the RPS-eligible resource(s) within that requirement
- Resources are assumed to come online by December 31st in the year prior to the listed COD to qualify for tax credits



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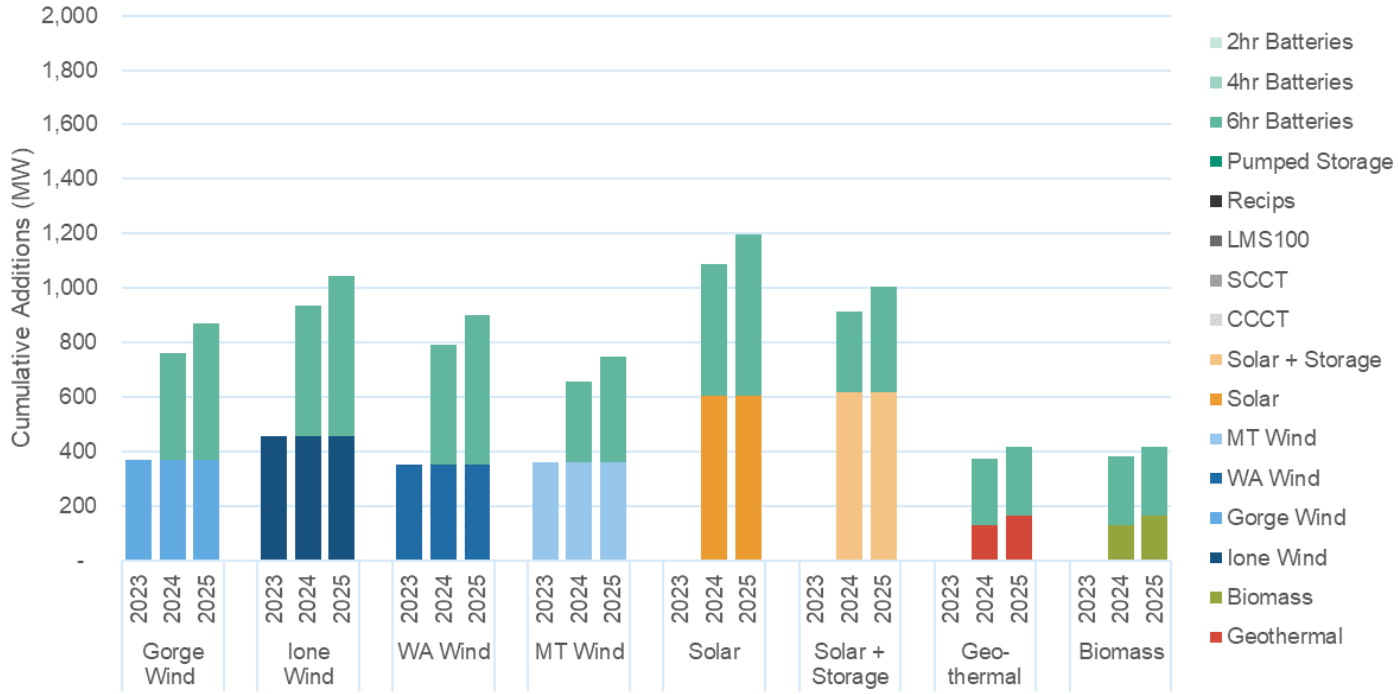
Renewable Resource Portfolios

- Investigates resource economics across various renewable resource types
- Each portfolio assumes 150 MWa renewable addition by 2023 (December 31, 2022), excludes thermal generation



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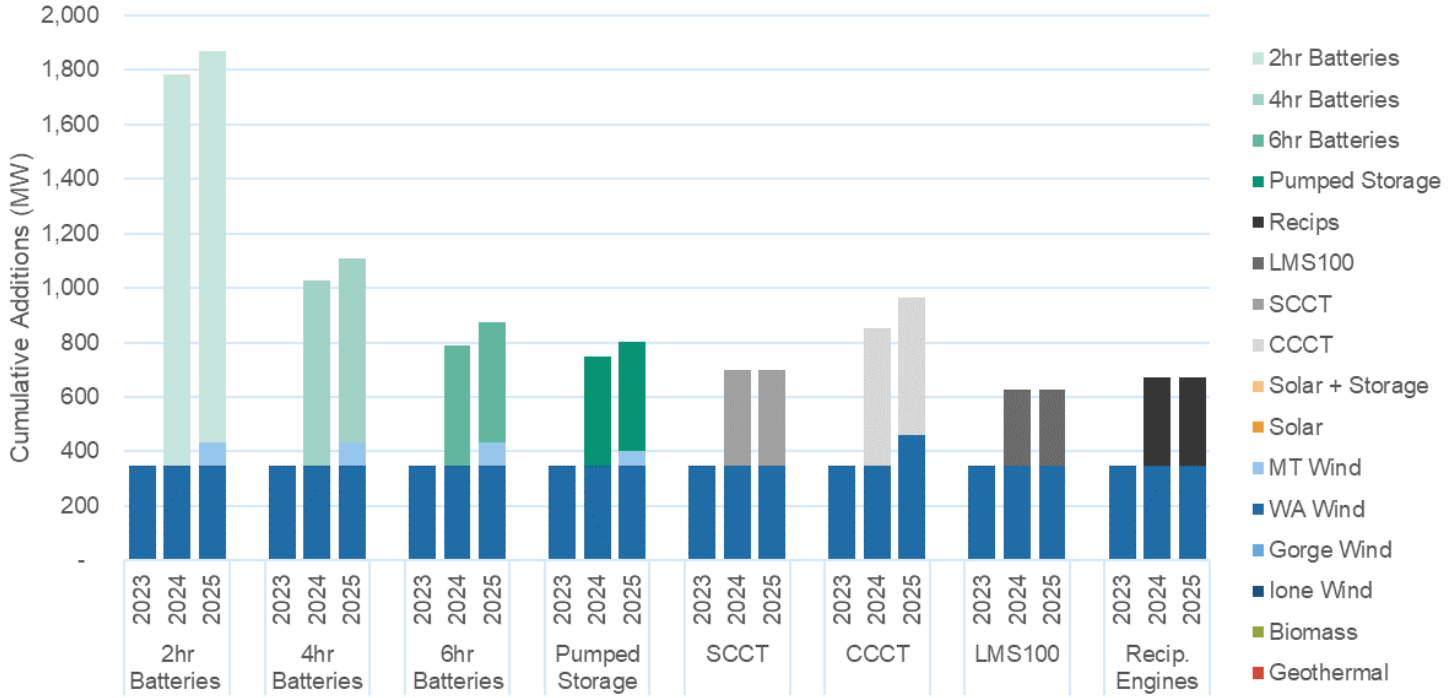
Dispatchable Capacity Portfolios

- Investigates resource economics across various dispatchable capacity technologies
- Each portfolio assumes 150 MWa Washington Wind addition in 2023



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Portfolio Scoring

Portfolio Scoring Overview

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

Scoring Metrics

Traditional Metrics

- Cost – Net present value revenue requirement (NPVRR) through 2050
- Variability – Semi-deviation of NPVRR across futures
- Severity – TailVAR90 of NPVRR across futures

Non-Traditional Metrics

- Portfolio Cumulative GHGs
- Near-term cost
- New Resource Criteria Pollutants*
- GHG-constrained cost
- Cost in High Tech Future
- Energy additions through 2025

*The "New Resource Criteria Pollutant" metric is expressed as the sum of cumulative NO_2, SO_2, and Particulate Matter emissions from new resources through 2050, in short tons.

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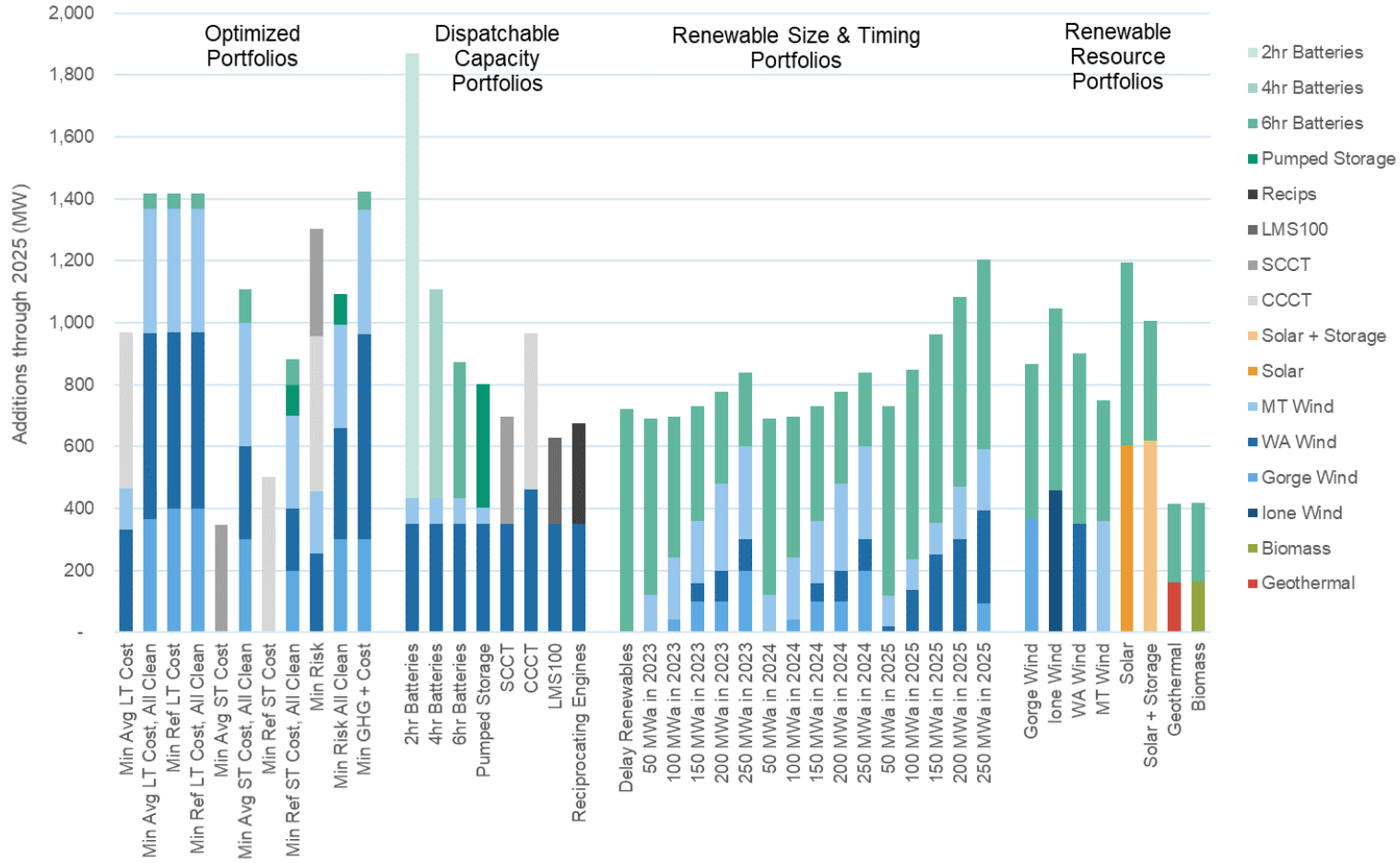
Portfolio Scoring

Scoring process begins with 43 candidate portfolios



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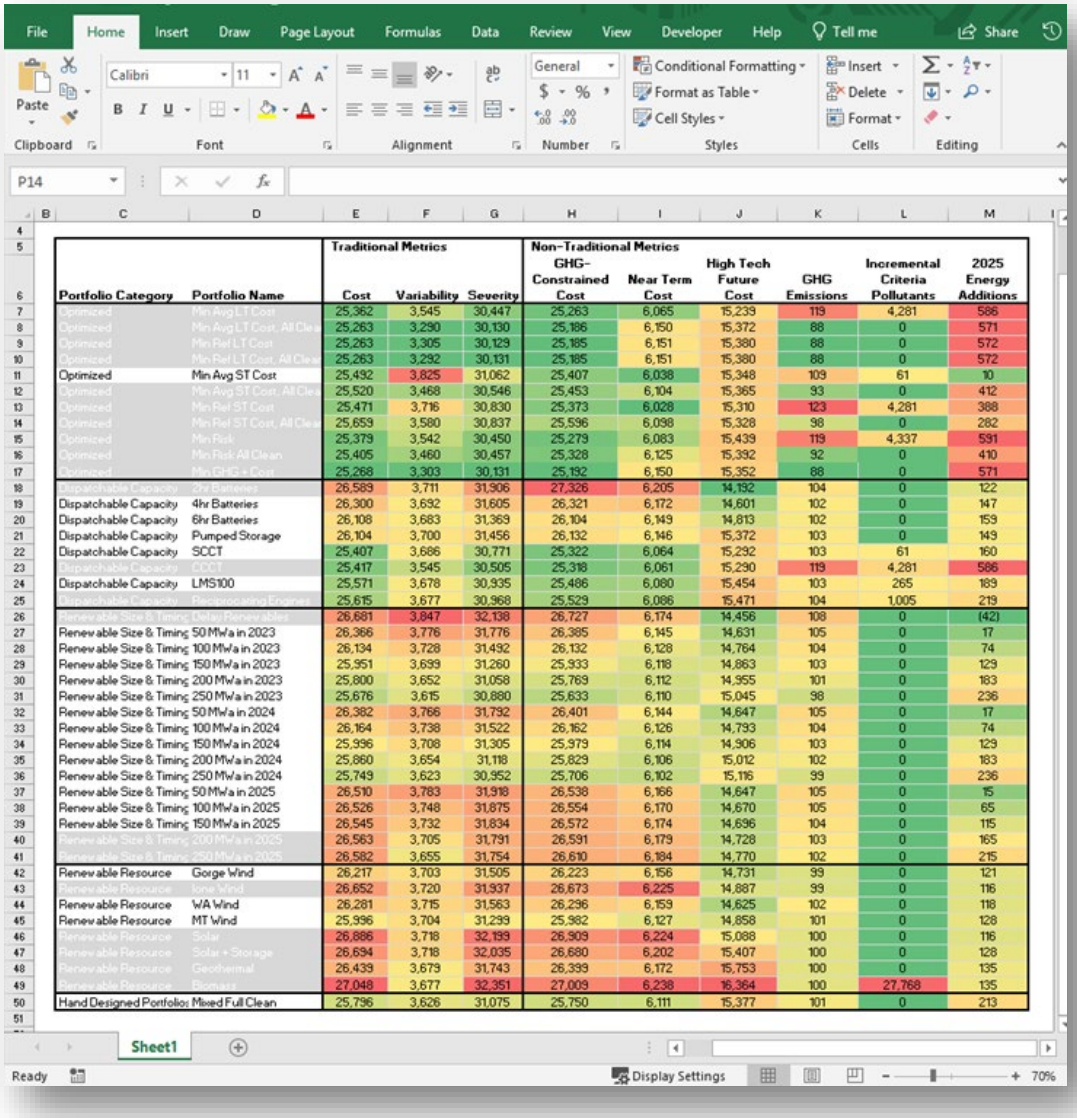
Portfolio Scores

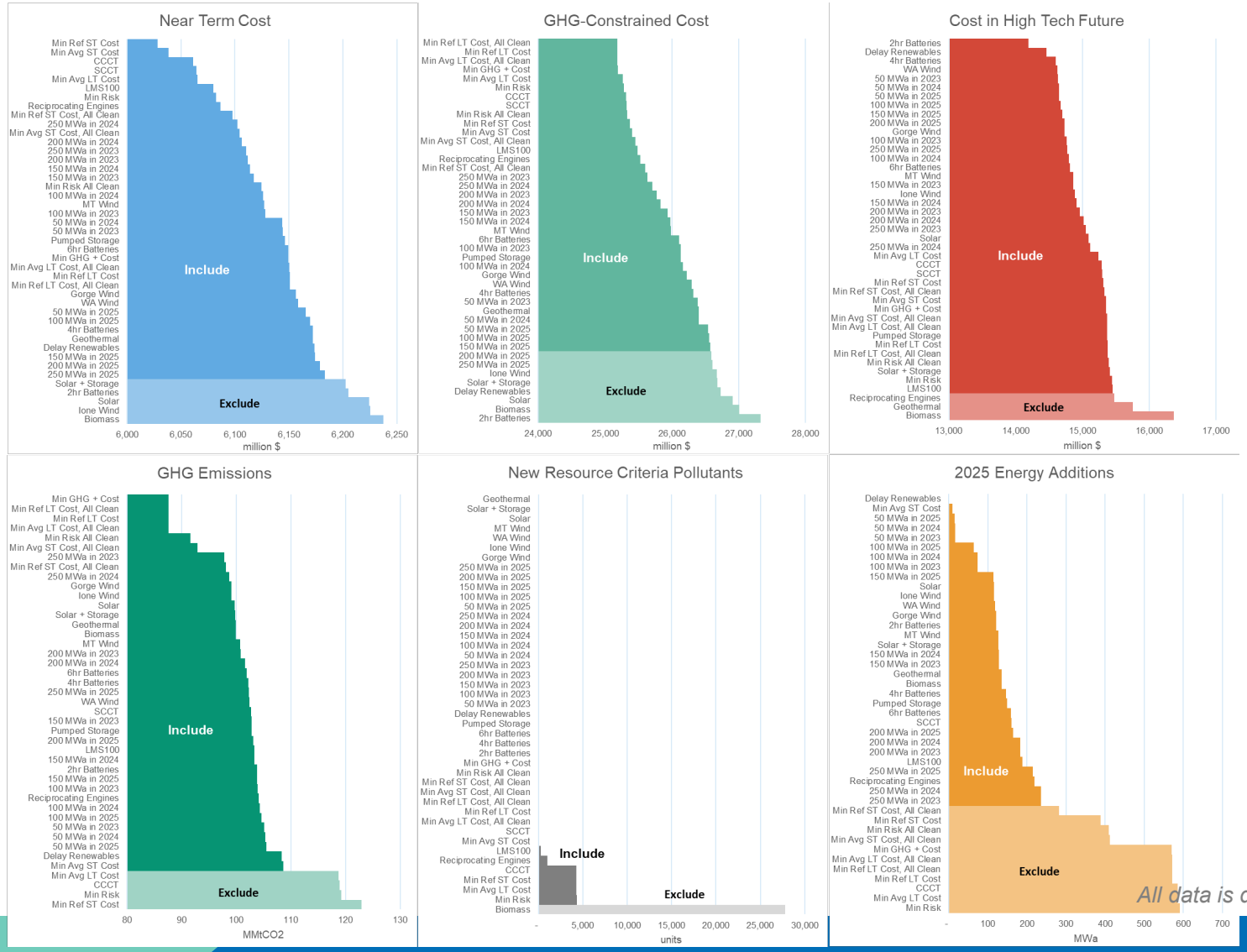
Draft portfolio scores (p. 173) are available in Excel format online at: [link]



Portfolio Category	Portfolio Name	Traditional Metrics: Cost	Traditional Metrics: Variability	Traditional Metrics: Severity	Non-Traditional Metrics: GHG-Constrained Cost	Non-Traditional Metrics: Near Term Cost	Non-Traditional Metrics: High Tech Future Cost	Non-Traditional Metrics: GHG Emissions	Non-Traditional Metrics: Incremental Criteria Pollutants	Non-Traditional Metrics: 2025 Energy Additions
Optimized	Min Avg LT Cost	25,362	3,545	30,447	25,263	6,065	15,239	119	4,281	586
Optimized	Min Avg LT Cost, All Clean	25,263	3,290	30,130	25,186	6,150	15,372	88	0	571
Optimized	Min Rel LT Cost	25,263	3,305	30,129	25,185	6,151	15,380	88	0	572
Optimized	Min Rel LT Cost, All Clean	25,263	3,292	30,131	25,185	6,151	15,380	88	0	572
Optimized	Min Avg ST Cost	25,492	3,825	31,062	25,407	6,038	15,348	109	61	10
Optimized	Min Avg ST Cost, All Clean	25,520	3,468	30,546	25,453	6,104	15,365	93	0	412
Optimized	Min Rel ST Cost	25,471	3,716	30,830	25,373	6,028	15,310	123	4,281	388
Optimized	Min Rel ST Cost, All Clean	25,659	3,580	30,837	25,596	6,038	15,328	98	0	282
Optimized	Min Risk	25,379	3,542	30,450	25,279	6,083	15,439	119	4,337	591
Optimized	Min Risk All Clean	25,405	3,460	30,457	25,328	6,125	15,392	92	0	410
Optimized	Min GHG + Cost	25,268	3,303	30,131	25,192	6,150	15,352	88	0	571
Dispatchable Capacity	2hr Batteries	26,589	3,711	31,906	27,326	6,205	14,192	104	0	122
Dispatchable Capacity	4hr Batteries	26,300	3,692	31,605	26,321	6,172	14,601	102	0	147
Dispatchable Capacity	6hr Batteries	26,108	3,683	31,369	26,104	6,149	14,813	102	0	159
Dispatchable Capacity	Pumped Storage	26,104	3,700	31,456	26,132	6,146	15,372	103	0	149
Dispatchable Capacity	SCCT	25,407	3,686	30,771	25,322	6,064	15,232	103	61	160
Dispatchable Capacity	CCCT	25,417	3,545	30,505	25,318	6,061	15,290	119	4,281	586
Dispatchable Capacity	LMS100	25,571	3,678	30,935	25,486	6,080	15,454	103	265	189
Dispatchable Capacity	Reciprocating Engine	25,615	3,677	30,968	25,529	6,086	15,471	104	1,005	219
Renewable Size & Timing	Delta Renewables	26,681	3,847	32,138	26,727	6,174	14,456	108	0	(42)
Renewable Size & Timing	50 MWa in 2023	26,366	3,776	31,776	26,385	6,145	14,631	105	0	17
Renewable Size & Timing	100 MWa in 2023	26,134	3,728	31,492	26,132	6,128	14,764	104	0	74
Renewable Size & Timing	150 MWa in 2023	25,951	3,699	31,260	25,933	6,118	14,863	103	0	129
Renewable Size & Timing	200 MWa in 2023	25,800	3,652	31,058	25,769	6,112	14,955	101	0	183
Renewable Size & Timing	250 MWa in 2023	25,676	3,615	30,880	25,633	6,110	15,045	98	0	236
Renewable Size & Timing	50 MWa in 2024	26,382	3,766	31,792	26,401	6,144	14,647	105	0	17
Renewable Size & Timing	100 MWa in 2024	26,164	3,738	31,522	26,162	6,126	14,793	104	0	74
Renewable Size & Timing	150 MWa in 2024	25,996	3,708	31,305	25,979	6,114	14,906	103	0	129
Renewable Size & Timing	200 MWa in 2024	25,860	3,654	31,118	25,829	6,106	15,012	102	0	183
Renewable Size & Timing	250 MWa in 2024	25,749	3,623	30,952	25,706	6,102	15,116	99	0	236
Renewable Size & Timing	50 MWa in 2025	26,510	3,783	31,918	26,538	6,166	14,647	105	0	15
Renewable Size & Timing	100 MWa in 2025	26,526	3,748	31,875	26,554	6,170	14,670	105	0	65
Renewable Size & Timing	150 MWa in 2025	26,545	3,732	31,834	26,572	6,174	14,696	104	0	115
Renewable Size & Timing	200 MWa in 2025	26,563	3,705	31,791	26,591	6,179	14,728	103	0	165
Renewable Size & Timing	250 MWa in 2025	26,582	3,655	31,754	26,610	6,184	14,770	102	0	215
Renewable Resource	Gorge Wind	26,217	3,703	31,505	26,223	6,156	14,731	99	0	121
Renewable Resource	Ione Wind	26,652	3,720	31,937	26,673	6,225	14,887	99	0	116
Renewable Resource	WA Wind	26,281	3,715	31,563	26,296	6,159	14,625	102	0	118
Renewable Resource	MT Wind	25,996	3,704	31,239	25,982	6,127	14,858	101	0	128
Renewable Resource	Solar	26,886	3,718	32,139	26,909	6,224	15,088	100	0	116
Renewable Resource	Solar + Storage	26,694	3,718	32,035	26,680	6,202	15,407	100	0	128
Renewable Resource	Geothermal	26,439	3,679	31,743	26,399	6,172	15,753	100	0	135
Renewable Resource	Biomass	27,048	3,677	32,351	27,009	6,238	16,364	100	27,768	135
Hand Designed Portfolio: Mixed Full Clean		25,796	3,626	31,075	25,750	6,111	15,377	101	0	213

1. Screening

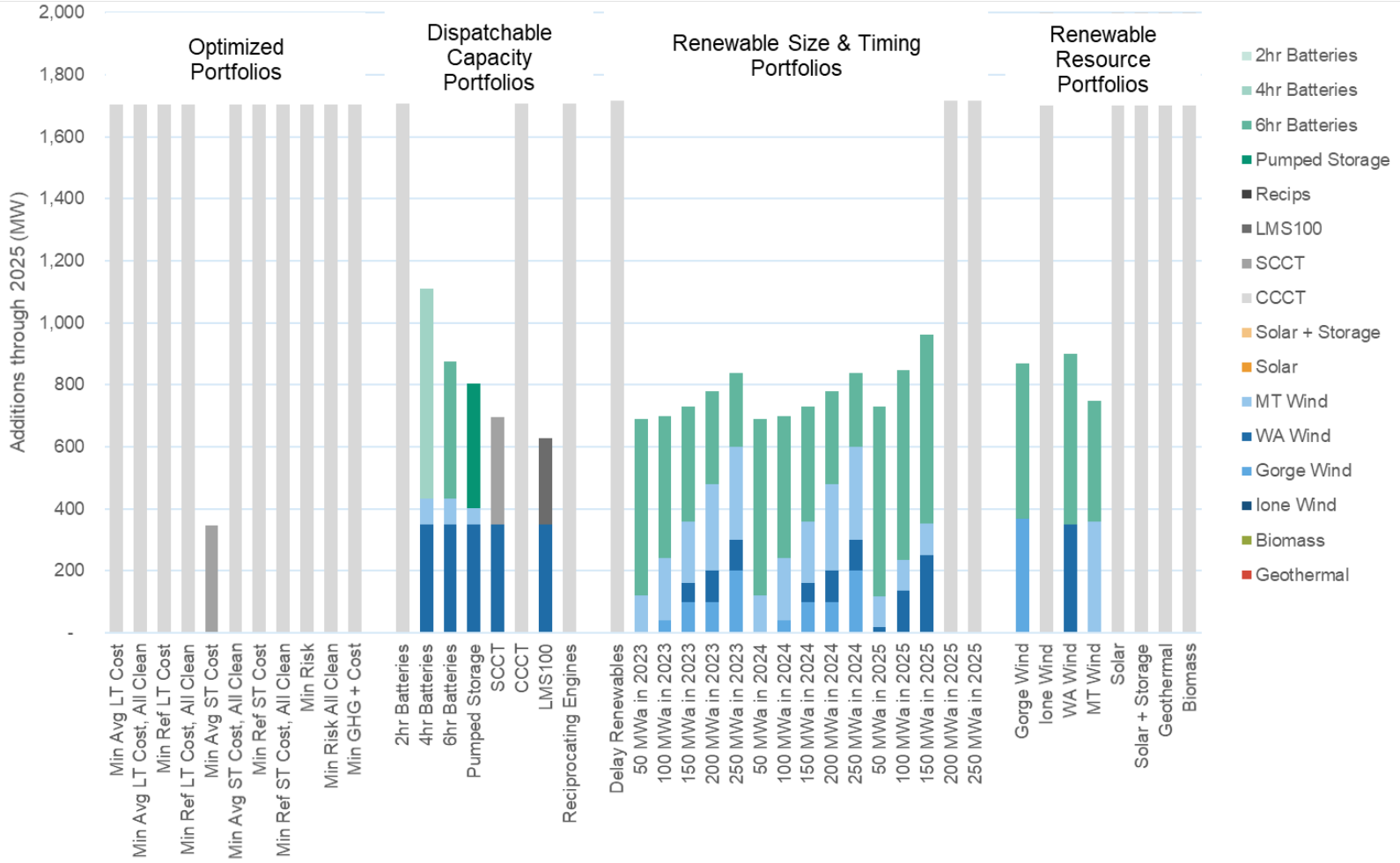
Based on non-traditional scoring metrics



All data is draft until filed.

1. Screening

Based on non-traditional scoring metrics



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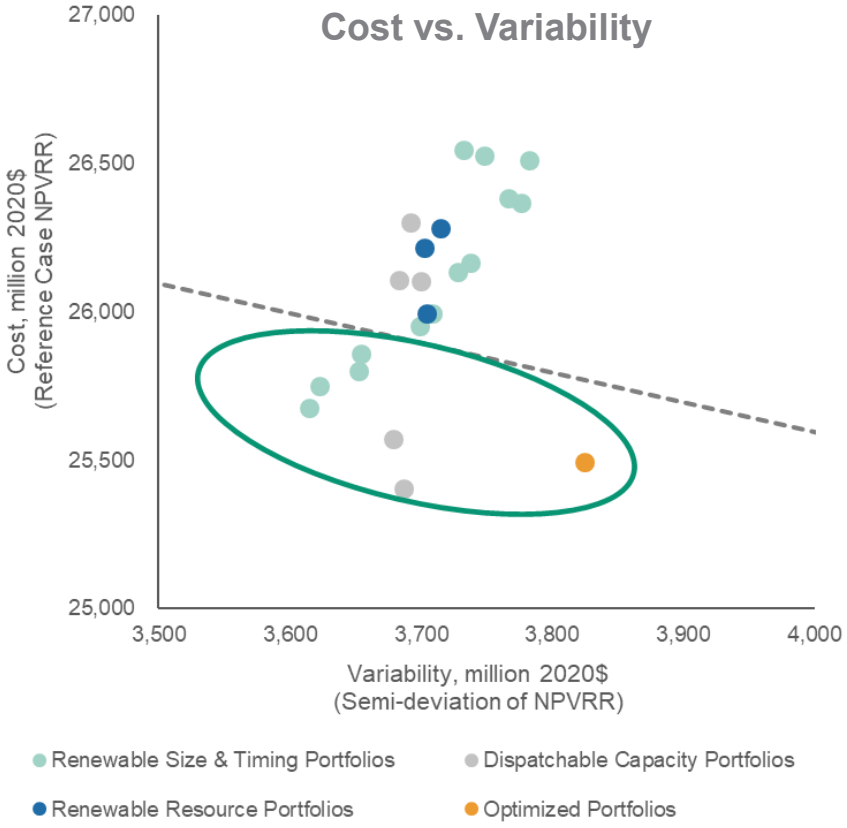
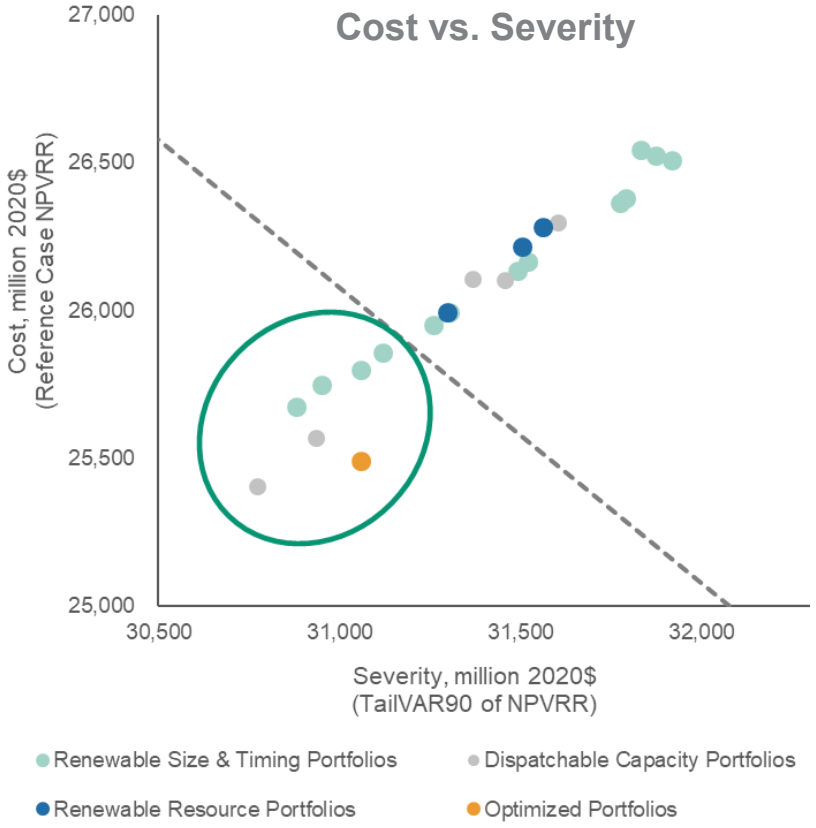
2. Evaluation

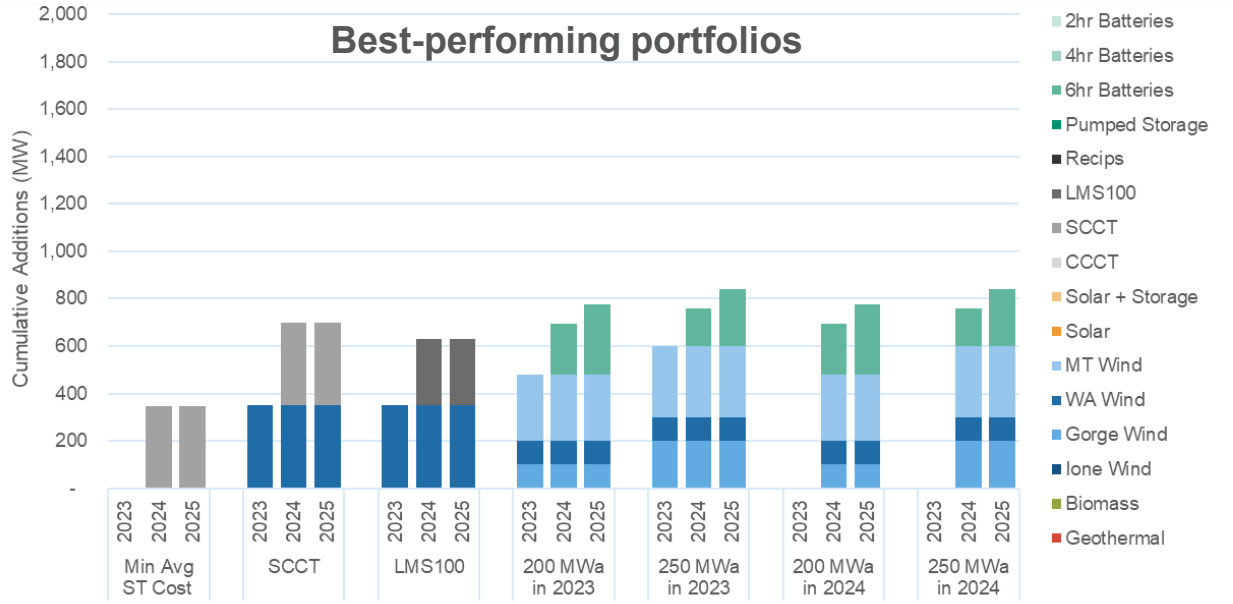
Based on traditional cost and risk metrics





3. Identification

of common aspects of well-performing portfolios



Portfolio	Category	Cost	Variability	Severity
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SCCT	Dispatchable Capacity	25,407	3,686	30,771
LMS100	Dispatchable Capacity	25,571	3,678	30,935
200 MWa in 2023	Renewable Size & Timing	25,800	3,652	31,058
250 MWa in 2023	Renewable Size & Timing	25,676	3,615	30,880
200 MWa in 2024	Renewable Size & Timing	25,860	3,654	31,118
250 MWa in 2024	Renewable Size & Timing	25,749	3,623	30,952

3. Identification

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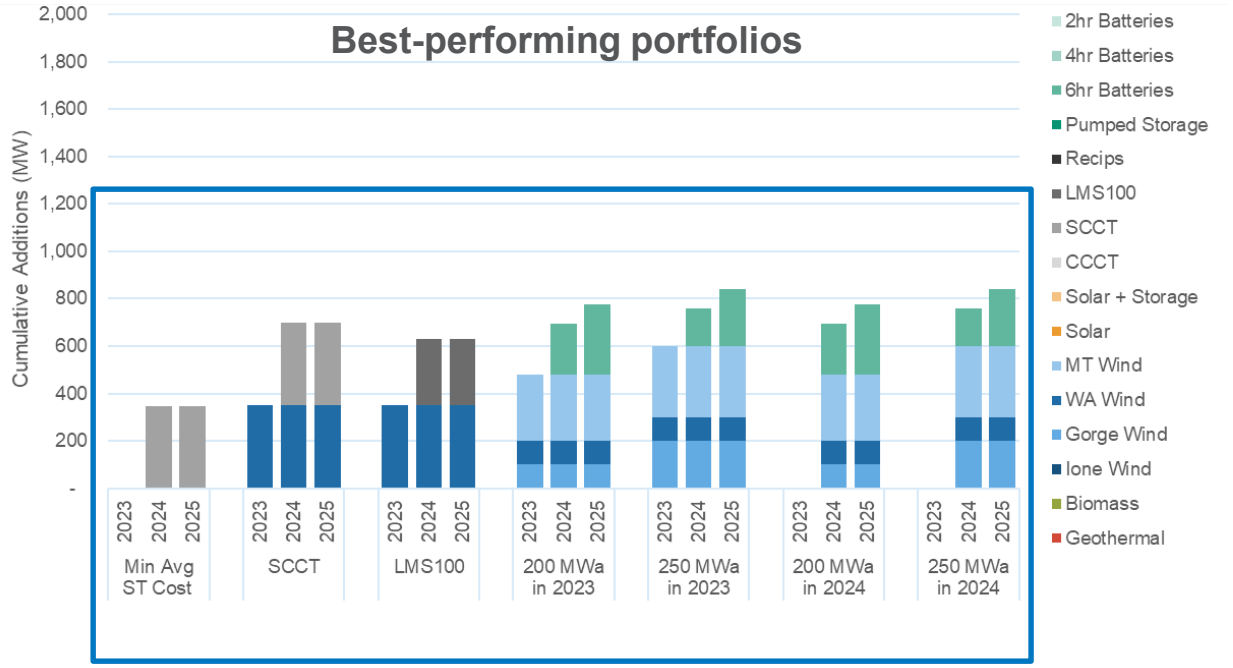

Customer Resources: All portfolios include all cost-effective energy efficiency and DER adoption and participation assumptions based on the Navigant DER Study.

3. Identification

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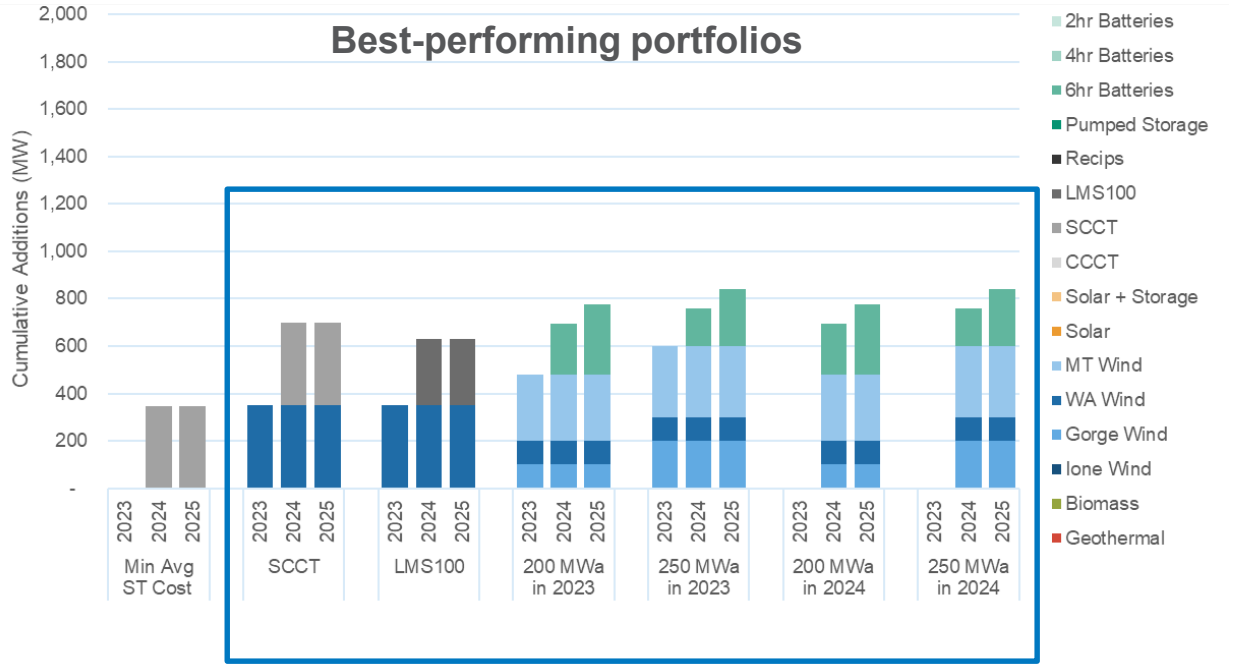
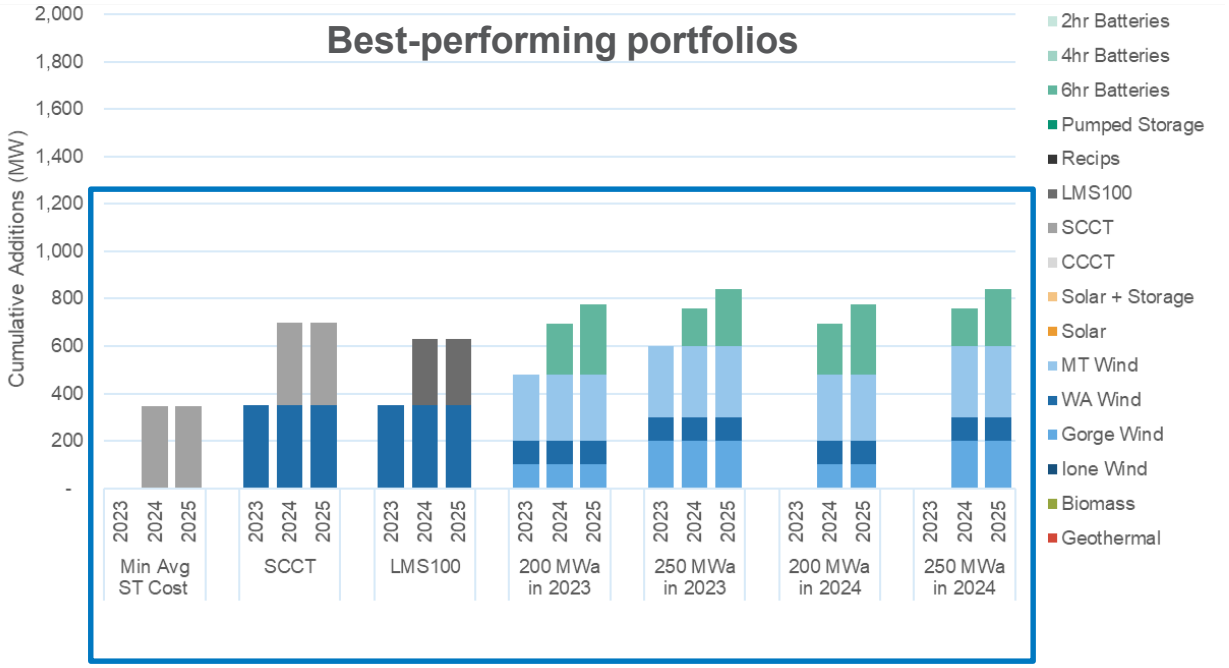


Renewable Resources: Six of the seven best-performing portfolios incorporate renewable actions prior to 2025. Renewable addition sizes across these six portfolios range from 150 MWa to 250 MWa.

3. Identification

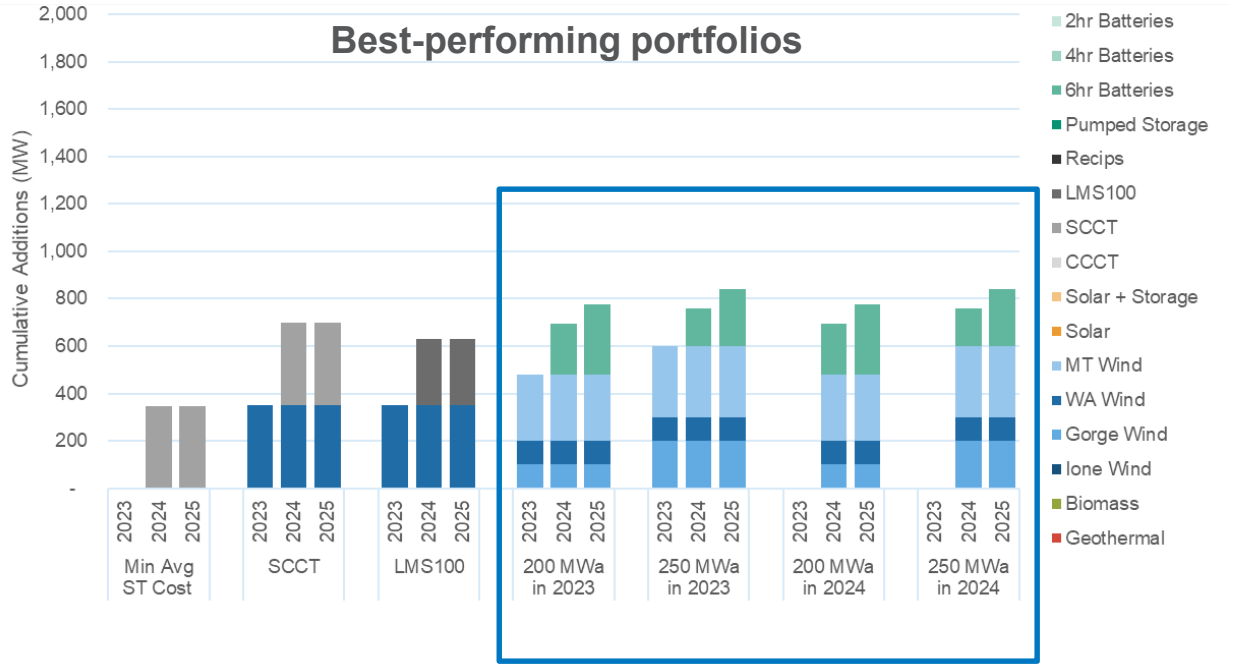
of common aspects of well-performing portfolios



Capacity Additions: All seven of the best-performing portfolios incorporate capacity additions prior to 2025 in addition to a limited amount of "Capacity Fill" resource (see p. 160).

3. Identification

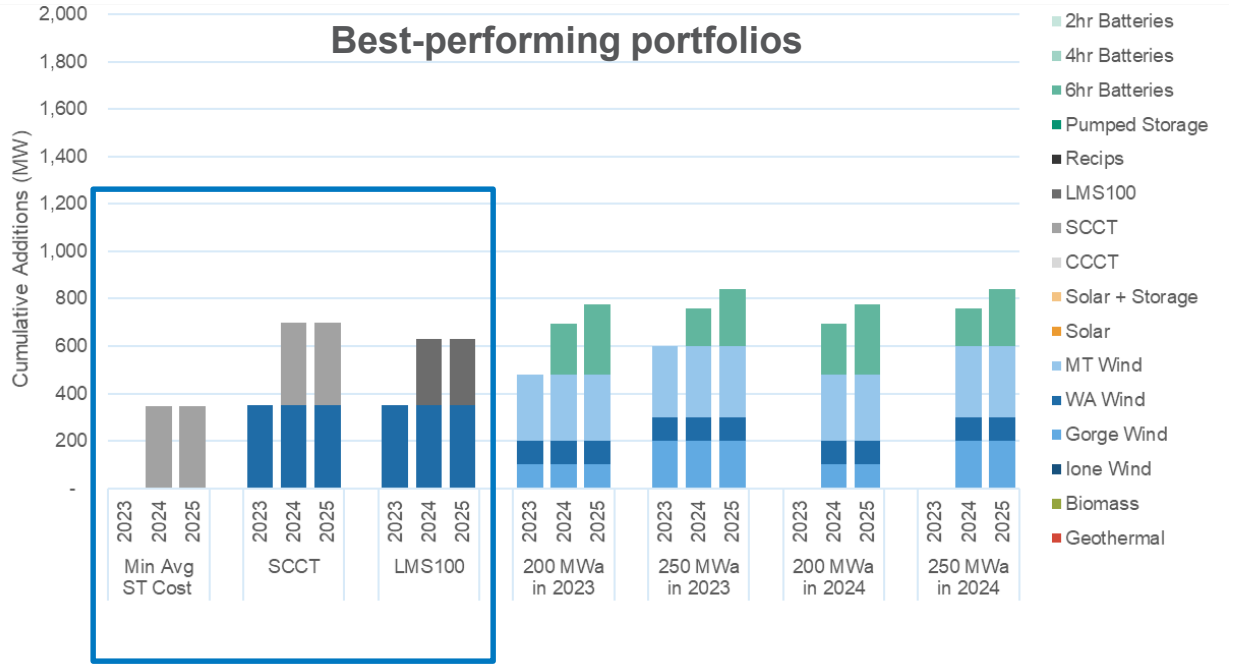
of common aspects of well-performing portfolios



Capacity Additions: Capacity is provided by battery storage in four portfolios. These portfolios add incremental capacity in both 2024 and 2025, totaling between 238 and 299 MW by 2025.

3. Identification

of common aspects of well-performing portfolios



Capacity Additions: Capacity is provided by thermal resources in three portfolios. These portfolios make capacity additions in 2024 aligning with thermal unit sizes, totaling between 279 MW and 347 MW.

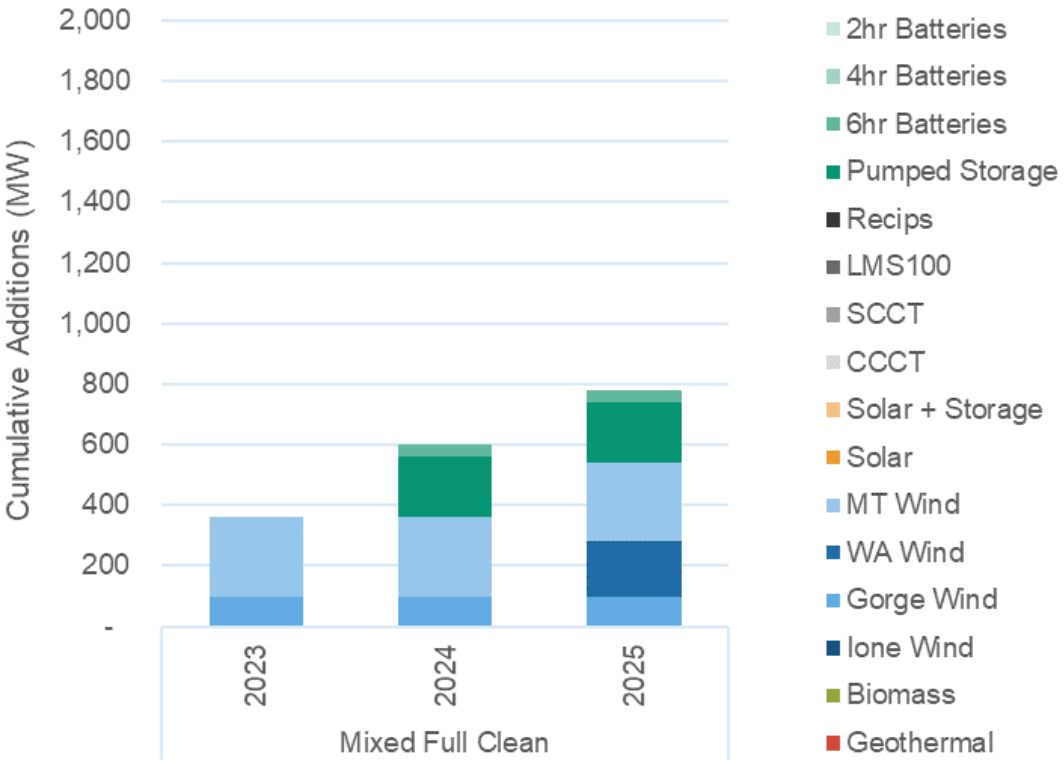
4. Selection
of a Preferred Portfolio

Based on the portfolios that perform the best on the basis of cost and risk, PGE designed the **Mixed Full Clean Portfolio**, which:

- Includes 150 MWa renewable addition by 2023
- Allows for additional renewables in 2025, if economic, consistent with a two-year renewable procurement cycle
- Excludes new GHG-emitting resources

Preferred Portfolio

Near-term resource additions



Mixed Full Clean Portfolio includes:

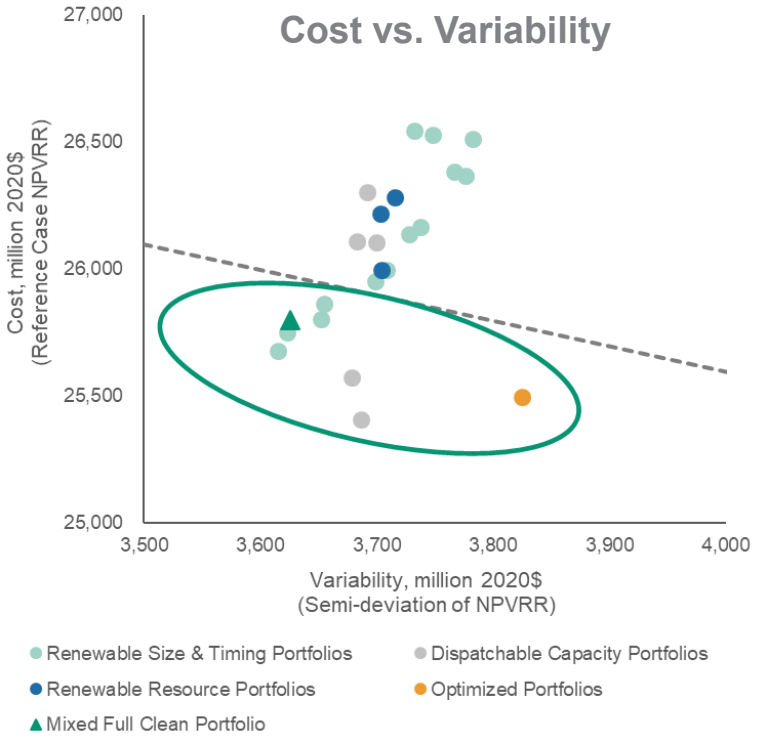
150 MWa of diverse wind resource additions in 2023

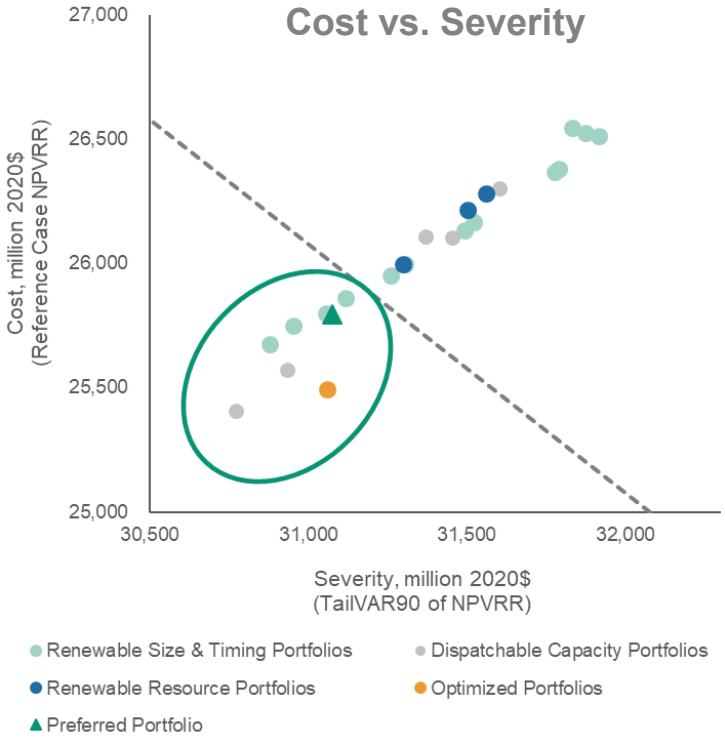
Additional wind in 2025

Storage (6 hour duration and longer) to meet remaining capacity needs, plus limited amount of Capacity Fill resource

Preferred Portfolio

Mixed Full Clean Portfolio is among the portfolios that perform the best on the basis of cost and risk

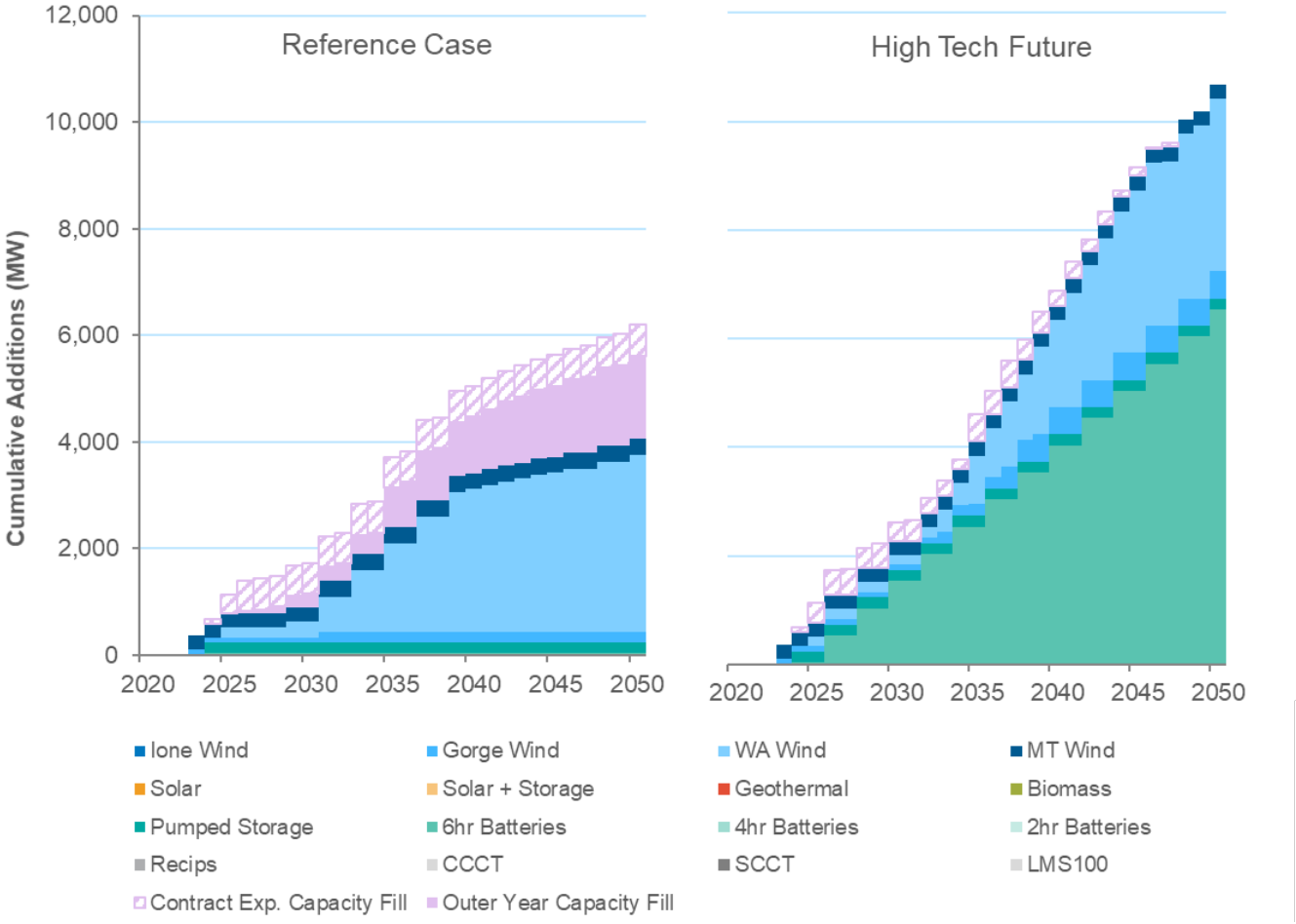




All data is draft until filed.

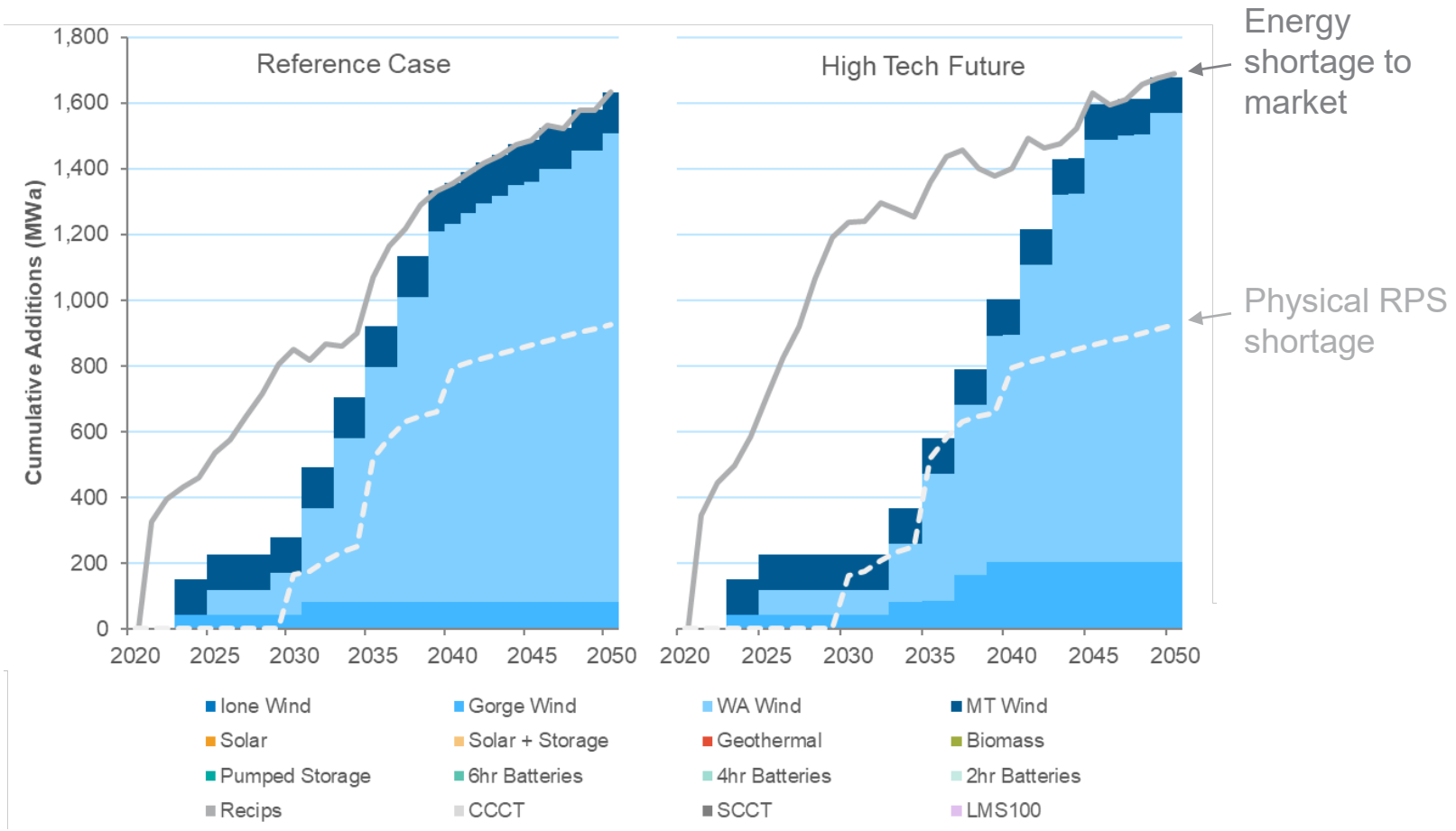
Preferred Portfolio

Capacity additions in specific futures



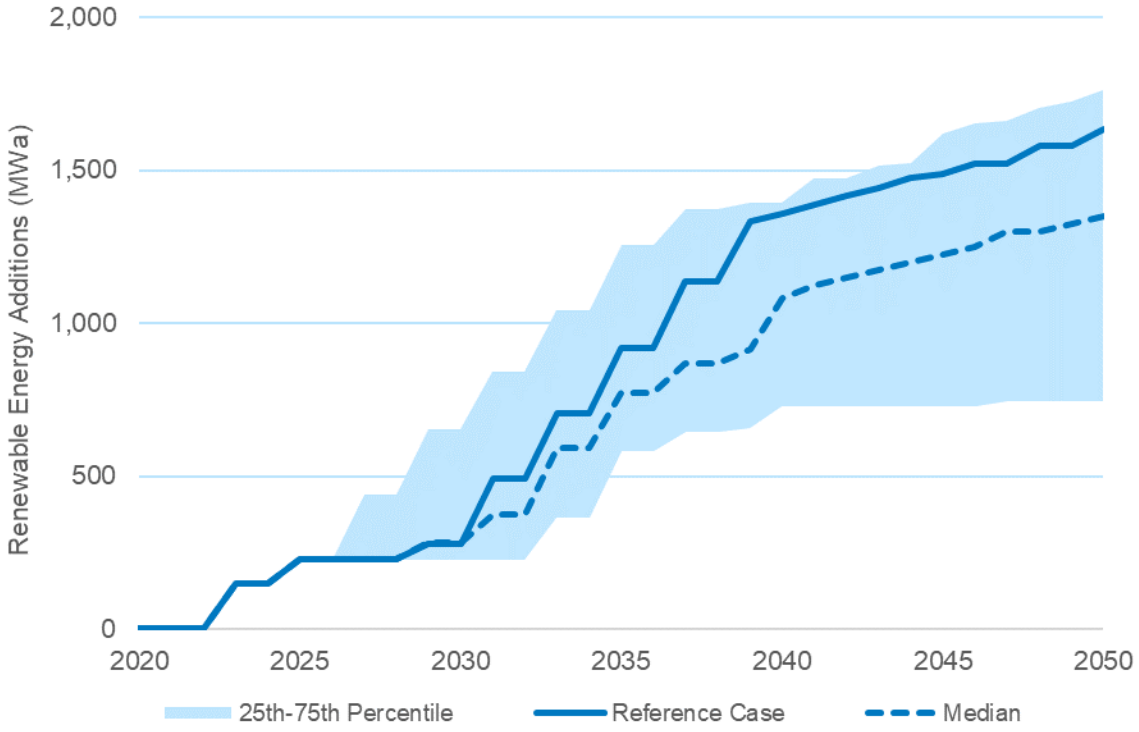
Preferred Portfolio

Energy additions in specific futures



Renewable Glide Path

The **Mixed Full Clean Portfolio** takes advantage of near-term economic opportunities to pursue cost competitive renewables while allowing for flexibility to adapt to future conditions



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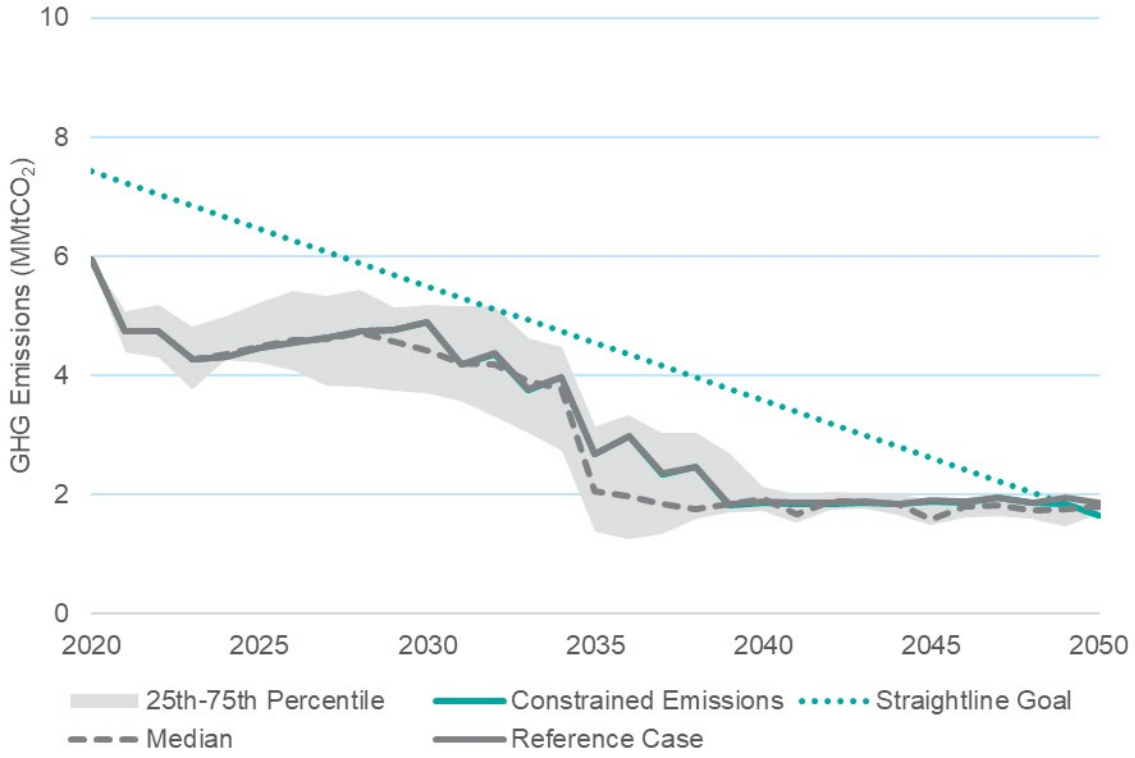
GHG Reductions

The **Mixed Full Clean Portfolio** will help PGE to make progress toward our goal to reduce GHGs by 80% by 2050



All data is draft until filed.

Draft Action Plan

Elaine Hart

Draft Action Plan

Customer Resources

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

1.B. 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 DSG
- 4.0 MW (Low: 2.2 MW, High: 11.2 MW) of dispatchable customer storage

*Values are cumulative and at the meter

All information is draft until filed.

Draft Action Plan
Renewable Resources

2. Conduct a Renewables RFP in 2020, seeking ~150 MWa of RPS-eligible resources, online by the end of 2023

- Timing allows PGE to capture ≥60% PTC for customers
- Propose cost containment screen similar to the 2018 Renewables RFP
- Propose to return value of RECs generated prior to 2030 to customers

All information is draft until filed.

Draft Action Plan

Dispatchable Capacity

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

All information is draft until filed.

Next Steps in the 2019 IRP

Elaine Hart

Next Steps

2019 IRP Process

- **May 17** – Released Draft 2019 IRP
- **May 20** – Open 2019 IRP docket
- **June 12** – PGE is planning a Community Listening Session to receive additional feedback on the Draft 2019 IRP
- **June 17** – Deadline for submitting informal comments on Draft 2019 IRP

  (email comments to IRP@pgn.com)
- **July 17** – File the 2019 IRP *(tentative)*

Thank you!

Contact us at:
IRP@pgn.com