AURORA MODELING ANALYSIS

APPENDIX A-1

PUGET SOUND ENERGY

Contents

1. Introduction and key assumptions

The 2021 IRP and CEAP set the stage for PSE to meet resource needs at the lowest reasonable cost while providing customer benefits over a 10-year horizon. The 2021 CEIP modeling process optimized resource additions to better represent target programs over 2022–2025. However, for this 2023 Biennial CEIP update, we are focusing on the remaining years 2024 and 2025 and meeting the targets.

The modeling assumptions and framework for this update build upon previous analytical work completed for the 2023 Electric Progress Report (2023 Report) provides a two-year progress report on the 2021 IRP as required by Clean Energy Transformation Act (CETA). These assumptions include temperature data that reflects climate change, updated ELCCs, and updates to short term market reliance. The assumptions and documentation of the 2023 Report model are in Chapter Five: Key Analytical Assumptions and Appendix H: Electric Analysis and Portfolio Model. The preferred portfolio is discussed in Chapter Three: Resource Plan. PSE filed the 2023 Report with the Washington Utilities and Transportation Commission on March 31, 2023. For the purposes of this study, the 2023 Biennial CEIP update, we looked at two portfolios:

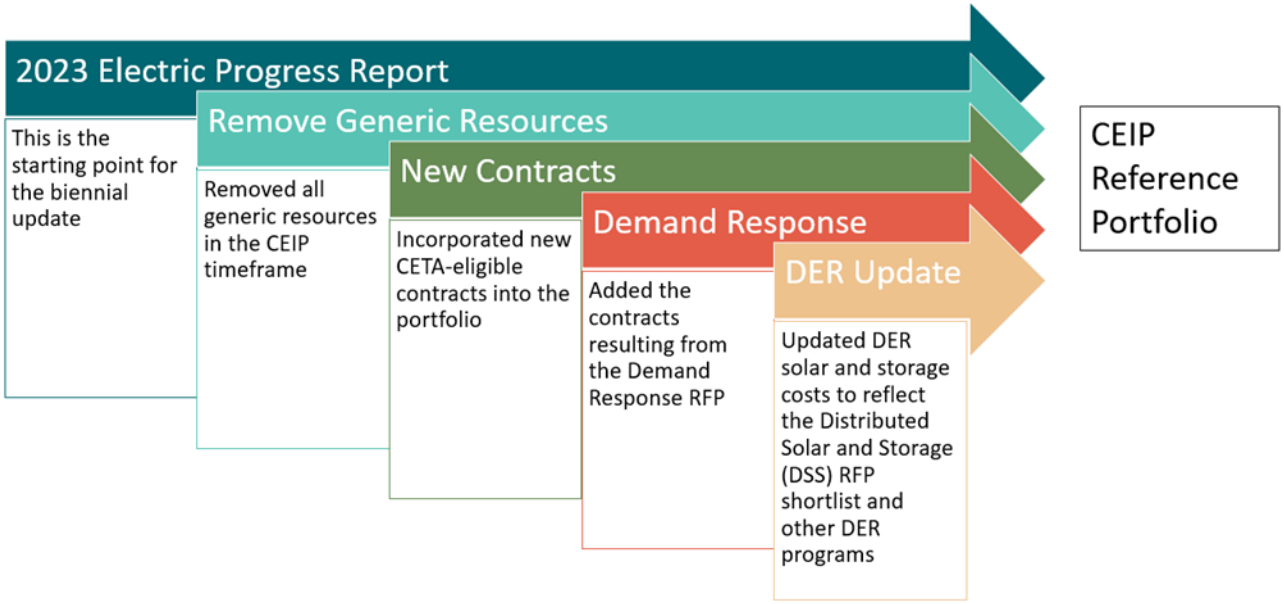
1. Reference portfolio based on modeling methodology from the 2023 Report
2. Reference Portfolio with the SCGHG as a dispatch cost

The following sections describe the updates we made and the modeling results for this 2023 Biennial CEIP Update.

2. Updates to the 2023 Report preferred portfolio

As part of this analysis, we made some updates to the 2023 Report preferred portfolio in order to capture recent acquisitions that occurred after the 2023 Report was finished.

Figure A-1.1: Modeling updates for 2023 Biennial Update



2.1. New supply-side resources

For the Biennial CEIP update, we incorporated new power purchase agreement to serve PSE customer load and meet projected capacity and renewable energy targets including:

- 2022 - 250 MW short-term transaction from renewable and nonemitting generation resources
- 2023 - 500 MW short-term transaction from renewable and nonemitting generation resources
- 2024 – 265 MW short-term transaction from renewable and nonemitting generation resources
- 2024 – 50 MW other short-term transaction(s)
- HF Sinclair co-generation PPA is a 140 MW co-generation project that started deliveries to PSE's system beginning January 1, 2023 and ends on September 30, 2025. It provides PSE with energy and capacity that is surplus to the requirements of the HF Sinclair refinery in Anacortes, WA.
- Vantage Wind Project PPA is a 90 MW contract with Vantage Wind Energy LLC located in Kittitas County, WA. The PPA is a 15-year contract starting on October 4, 2025 and ending on October 31, 2040.
- BPA Call Option contract is a 100 MW call option available for purchase during peak hours for up to 8 hours per peak day. The contract started in January 2020 and extends through December 2026. This is an existing contract, but a modeling correction was made to count 95% of the generation from this contract as CETA qualifying energy in the 2023 Biennial CEIP Update.

2.2. Energy efficiency

Energy efficiency savings for the years 2024 and 2025 were updated in the 2023 Biennial CEIP Update to reflect draft energy efficiency energy goals established by the 2023 Biennial Conservation Plan. At

the time of writing the values for the 2023 Biennial Conservation Plan have yet to be finalized for publication in November of 2023 and therefore specific values may differ between the 2023 Biennial Update and the 2023 Biennial Conservation Plan.

Energy efficiency savings for model years after 2026, not specifically reported in this chapter, carried forward energy efficiency savings selected as part of the 2023 Electric Progress Report. Values are consistent with bundle 7 from the 2023 Conservation Potential Assessment as described in Appendix E: CPA and Demand Response Assessments of the 2023 Report.

2.3. Demand response

Demand response programs modeled in the 2023 Biennial CEIP Update reflect three selected offers from the 2022 Demand Response and Distributed Energy Resources Request for Proposal (2022 DER RFP). Selected offers include demand response programs from bidders AutoGrid, Oracle and Enel-X and include a range of products for both summer and winter peak management. At the time of modeling specific program capacities and operating parameters were still under development, therefore data used in models is reflective of bidder submitted data at the time of the 2022 DR/DER RFP.

2.4. Distributed solar and storage

Distributed solar and storage programs modeled in the 2023 Biennial CEIP Update represent a range of products and programs forecast through results of the 2023 Distributed Solar and Storage Request for Proposal (2023 DSS RFP) and internal PSE teams. Table A-1.1 provides a summary of the different types of products and programs modeled. This suite of products and programs replaces the generic placeholder resources used to model CEIP solar and storage targets in the 2023 Report.

Table A-1.1. Distributed solar products and programs

Product	Capacity 2024 (MW)	Capacity 2025 (MW)	Origin
DSS RFP Solar Offers[1]	1.7	55.0	2023 DSS RFP
New PSE Owned Community Solar	0.5	1.3	DER Customer Products
Existing PSE Owned Community Solar	10.0	10.0	DER Customer Products
Solar Purchase Rate	4.1	13.6	DER Customer Products
Residential Rent-to-Own	0.0	2.0	DER Customer Products
Green Power Solar Grants	1.2	2.2	DER Customer Products
DEA Solar Pilot	0.5	2.0	DER Customer Products
DSS RFP Storage Offers	0.0	33.5	2023 DSS RFP

1. A portion of 2023 DSS RFP Solar offers may contribute to future Community Solar products offered by PSE.

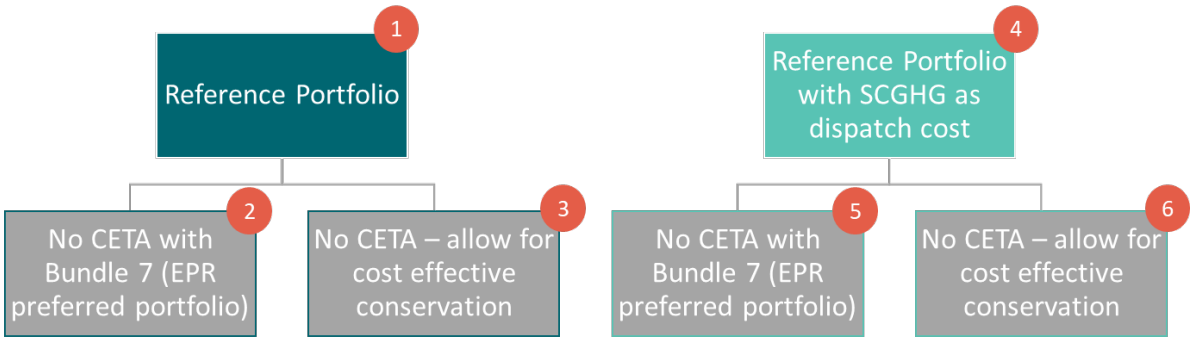
2.5. Non-wires Alternatives

Non-wires Alternative projects represent solar and storage resources which are installed to help address specific, long-term needs identified in the transmission and distribution systems. The forecast for non-wires alternatives projects reflects recent updates since the 2023 Report which suggest that no NWA projects will come online until 2027.

3. Portfolio analysis

We modeled two portfolios in this 2023 Biennial Update (Figure A-1.2), which presents two different methodologies for modeling the Social Cost of Greenhouse Gas (SCGHG). Portfolio 1 methodology aligns with the 2023 Report: the SCGHG is accounted for as an externality cost associated with emitting resources and is incorporated into the total cost of these resources over the planning horizon. Portfolio 4 methodology instead accounts for SCGHG costs in the dispatch of emitting resources. Both portfolios incorporate all updates discussed in Section 2, above. Furthermore, generic resources additions are prohibited in the model years 2024 and 2025, since construction and acquisition of new resources in under 2years is unlikely, therefore we only modeled existing and newly signed contracts during this period.

Figure A-1.2. Portfolios Modeled in the 2023 Biennial CEIP Update



Portfolios 2, 3, 5, and 6 model portfolio costs and builds in the absence of CETA requirements and provide data to calculate the incremental costs of CETA. Portfolios 2 and 5 replicate the amount of conservation selected in the 2023 Report Preferred Portfolio (65 MW by 2025); while Portfolios 3 and 6 allow for cost-effective conservation, resulting in 51 MW by 2025. Section 3.3 presents the incremental costs and the costs of conservation. Since the purpose of these portfolios is to juxtapose them against the Reference Portfolios 1 and 4, further results are not presented nor discussed.

3.1. Meeting CETA interim targets

This section describes how the portfolios modeled for the 2023 Biennial update relate to the interim targets established in the 2021 CEIP. These relationships are used to help inform revised interim targets described in Chapter 2 of this report.

Both portfolios exceed the renewable energy interim target of 59% in 2024 due to the combination of new supply-side resource contracts; energy efficiency and demand response programs acquired; and distributed generation and storage projects installed. Both portfolios are 64% renewable in 2024 (Figure A-1.3). Furthermore, these updates enable us to meet our winter peak capacity needs in 2024 (Figure A-1.4).

In 2025 both reference portfolios are 56% renewable, which is lower than our 2021 CEIP interim target of 63%. Additionally, we are short 111 MWs of winter peak capacity (Figure A-1.3). Expiring Columbia River hydro power contracts, in combination with a higher load forecast than was used in the 2021 CEIP, drive this deficit in both renewable and peak capacity, despite the updates described above. The 2023 Report Preferred portfolio achieved the 63% interim target largely by building 700 MWs of new wind resources, 200 MWs of new solar resources, and 200 MWs of battery storage. Though we are working diligently to fill this need, our 2021 All-Source RFP process did not result in available resource additions that align with this 2023 Report strategy (Table A-1.2). This Report's modeling reflects our knowledge and assumptions as of August 2023. In the intervening time between August 2023 and December 2025, we will be actively working to secure renewable and non-emitting capacity to meet this need.

Figure A-1.3: Renewable Energy contribution, 2024-2025

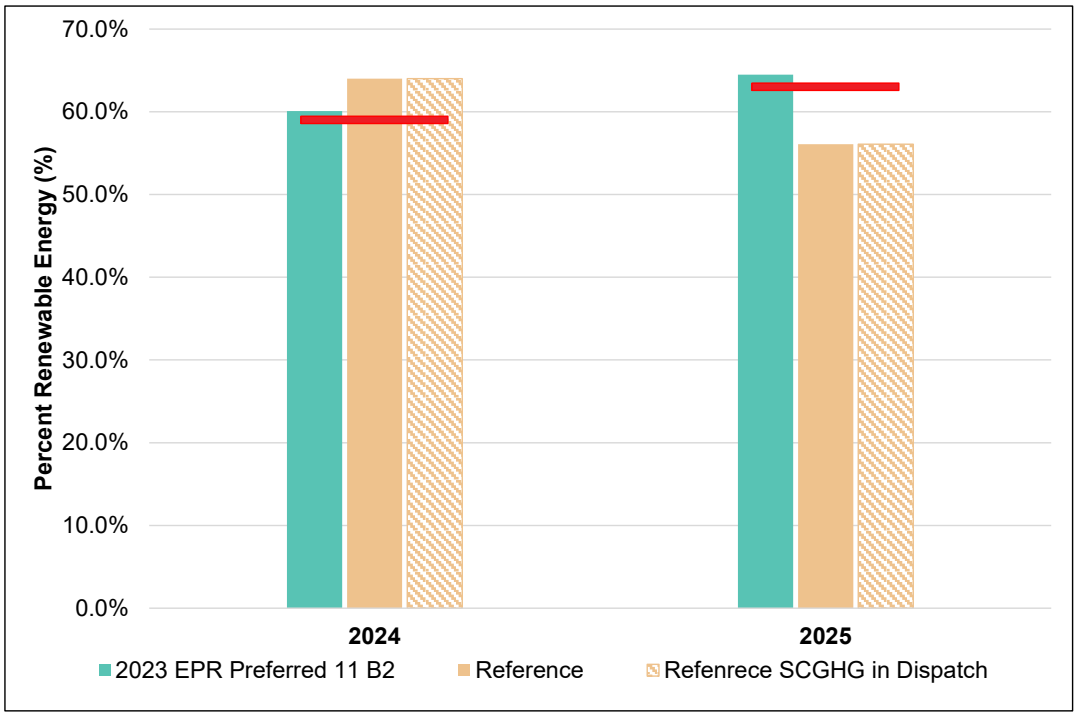


Figure A-1.4. Winter peak capacity contribution, 2024-2025

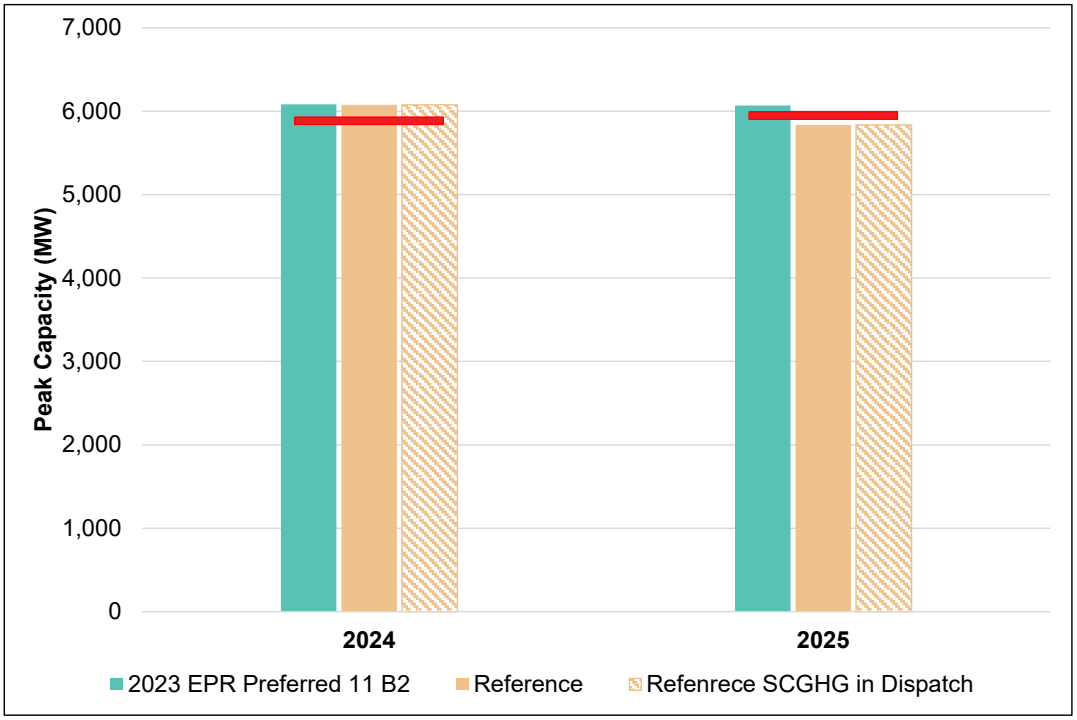


Table A-1.2: 2023 Report, cumulative resource additions (MW), 2024-2025

Cumulative additions 2024-2025 (MW)	2023 EPR Preferred Portfolio	Reference	Reference SCGHG in dispatch
Demand Side Resources	**201**	**156**	**156**
Conservation	65	65	65
Demand Response	136	90	90
Distributed Energy Resources	**212**	**187**	**187**
DER Solar	172	139	139
DER Storage	40	48	48
Supply Side Resources	**1,337**	**0**	**0**
Emitting Peaking Capacity	0	0	0
CETA Qualifying Peaking Capacity	237	0	0
Wind	600	0	0
Solar	100	0	0
Green Direct	0	0	0
Hybrid (Generation + Storage)	300	0	0
Biomass	0	0	0
Nuclear	0	0	0
Standalone Storage	100	0	0
New Supply-Side Resources/Contracts	**0**	**1,077**	**1,077**
CETA-eligible short-term transaction(s)		697	697

Cumulative additions 2024-2025 (MW)	2023 EPR Preferred Portfolio	Reference	Reference SCGHG in dispatch
HF Sinclair Co-Generation PPA		140	140
Vantage Wind Project PPA		90	90
Other short-term transaction(s)		50	50
BPA Call Option		100	100
Total	**1,750**	**1,420**	**1,420**

3.2. Portfolio cost

The portfolio costs for year 2024 and 2025 include the costs to operate and maintain existing resources as well as the agreed upon pricing for the new supply-side contracts, demand response and energy efficiency programs, and the costs to construct, operate, and maintain new distributed solar and storage resources. Both portfolios match in costs in years 2024 and 2025, and are similar to the 2023 Report Preferred portfolio costs during these years (Figure A-1.5). Accounting for SCGHG costs in the dispatch of emitting resources does not markedly change the overall cost of emissions in years 2024 and 2025, with both reference portfolio emissions costs at $480 million dollars in 2024 and $560 million dollars in 2025. Table A-1.3 presents the two-year net present value of the portfolio and SCGHG costs.

Figure A-1.5. Annual portfolio costs with and without the Social Cost of Greenhous Gas, 2024-2025

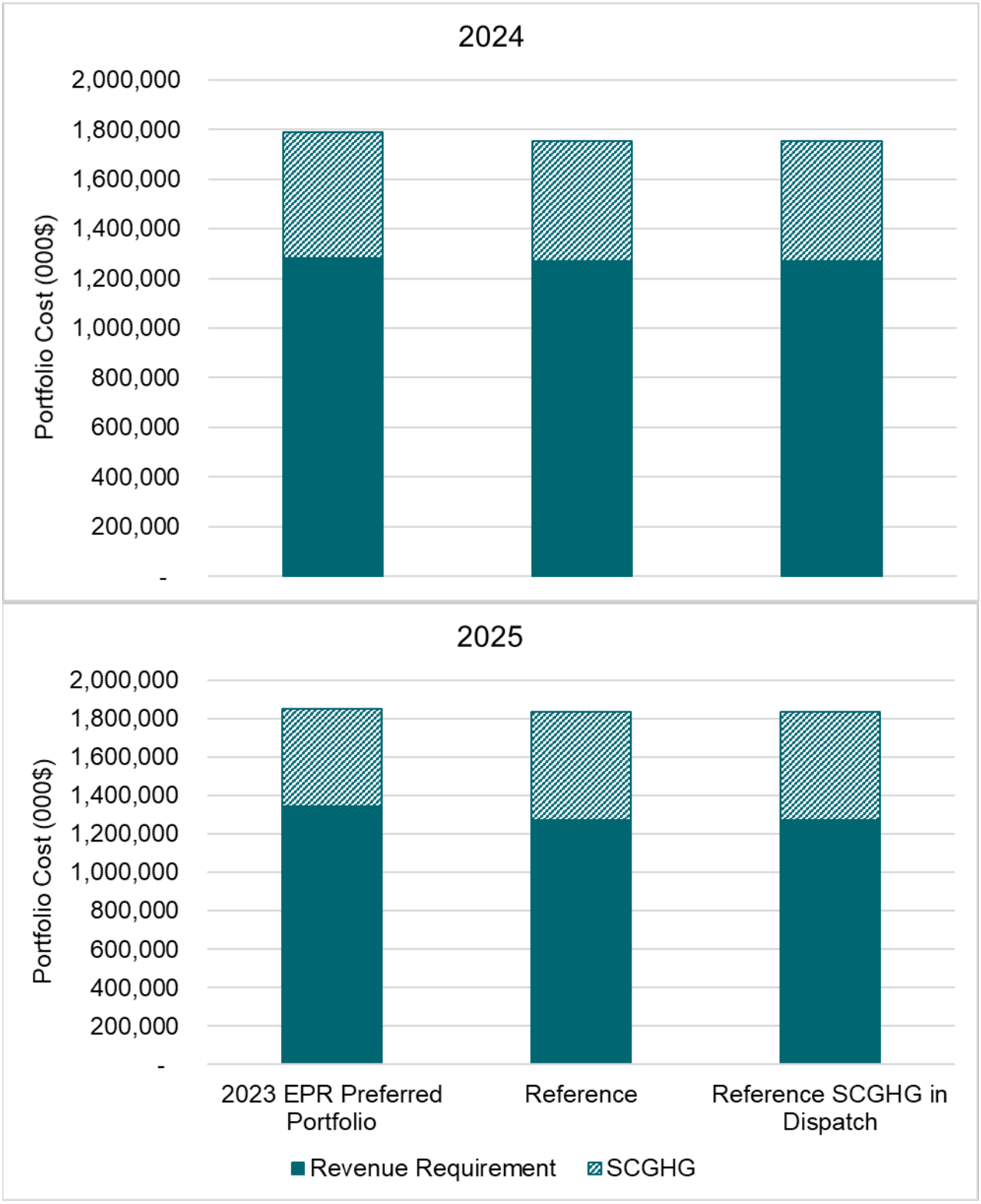


Table A-1.3: Two-year net present values, 2024-2025 ($ billions)

Portfolio	Portfolio Cost with SCGHG	Portfolio Cost without SCGHG	Social Cost of Greenhouse Gases (SCGHG)
2023 EPR Preferred Portfolio	3.30	2.38	0.92
Reference	3.25	2.31	0.94
Reference SCGHG in dispatch	3.24	2.31	0.94

3.3. Incremental cost

In terms of utility scale resources, the Commission's methodology for calculating incremental cost focuses specifically on how CETA's clean energy targets impact portfolio costs, **after** considering the impact of incorporating the SCGHG in the planning process. The incremental cost calculations presented here are for comparative modeling purposes and are not a measure of rate impacts. Incremental cost measures the difference in cost between a fully CETA-compliant reference portfolio, which includes both the SCGHG and clean energy targets, and a portfolio that removes the clean energy target constraint and therefore, may not be fully CETA-compliant. Table A-1.4 shows a comparison of the two SCGHG methodologies and the difference in incremental costs performed solely for the purposes of complying with Condition 32 and shows the results calculated over a two-year period. Both SCGHG methodologies result in similar portfolios and therefore, incremental costs for each methodology are similar. This calculation did not inform the updates PSE is seeking for its annual goals or interim target in this Biennial Update. The drivers for PSE's updates to targets are explained fully in Chapter 2.

Table A-1.4: Comparison of the incremental cost between PSE and alternative methodology

Year	Incremental Cost PSE Method (based on Portfolios 1, 2, & 3)	Incremental Cost Alternative Method (based on Portfolios 4, 5, & 6)	Difference between PSE method and Alternative
2024	$20,925,666	$21,405,048	($479,382)
2025	$21,503,108	$20,341,605	$1,161,502

4. Risk analysis

We conducted a suite of qualitative and quantitative analysis to assess the risks related to portfolio cost and our ability to meet CETA renewable energy targets established in the 2021 CEIP.

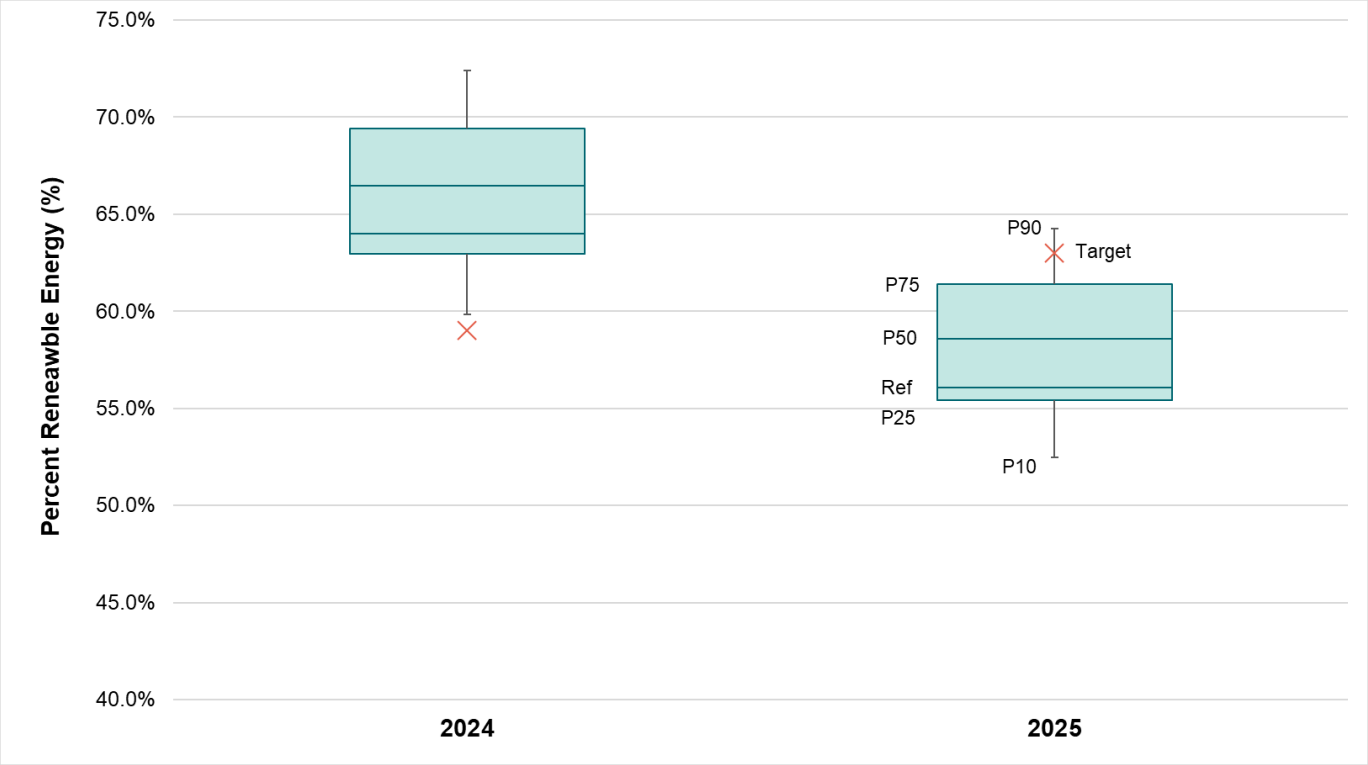
4.1. Meeting CETA targets

We assessed the risk impacts due to variability of renewable energy production on our ability to meeting CETA renewable energy targets. Renewable energy variability was quantified using a subset of the stochastic wind, solar and hydro generation data described in Appendix H: Electric Analysis and Portfolio Model of the 2023 Electric Progress Report. Each wind and solar resource is modeled with

250 possible stochastic draws and each hydro facility is modeled with 90 possible stochastic draws. Instead of a full Monte Carlo analysis using all stochastic draws, draws for the 10th, 25th, 50th, 75th and 90th percentile for each resource were extracted and passed to the Aurora model to simulate dispatch at these various renewable generation levels.

Figure A-1.6 presents the results of the renewable generation risk analysis for the model years 2024 and 2025 in Portfolio 1. The chart shows box plots of the percent of renewable energy delivered for each percentile of wind, solar and hydro output simulated to illustrate a range of possible outcomes. In model year 2024, it is very likely that we will meet the CETA renewable energy target as shown by the P25 (bottom of the box) generation exceeding the target. However, in 2025, it is less likely we can meet the 63% renewable generation target with our current projected portfolio given that only the 90th percentile of renewable and hydro generation exceed the target.

Figure A-1.6. Percent of renewable generation under various generation regimes



4.2. Costs of resources with inflation

We sourced the generic resource costs for renewable, energy storage, and thermal resources described in the following pages primarily from the National Renewable Energy Laboratory (NREL) 2022 Annual Technology Baseline (ATB). We also used input from publicly available data sources, including the U.S. Energy Information Administration (US EIA), Lazard, the Northwest Power and Conservation Council (NPCC), other national laboratories, and other regional IRPs. All cost assumptions are in 2020 dollars, with a 2.5 percent inflation applied through the planning horizon. The

2.5 percent represents the inflation rate of the general economy. The costs of renewable resources could be subject to higher inflation rates specific to the sector with increased demand as a result of renewables goal across the country. Higher inflation rate would not likely change the type of resource chosen if prices move in sync with each other.