EXH. CPC-9HC
DOCKETS UE-240004/UG-240005
2024 PSE GENERAL RATE CASE
WITNESS: COLIN P. CROWLEY

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY,** **Respondent.**	**Docket UE-240004** **Docket UG-240005**

EIGHTH EXHIBIT (HIGHLY CONFIDENTIAL) TO THE PREFILED DIRECT TESTIMONY OF

COLIN P. CROWLEY

ON BEHALF OF PUGET SOUND ENERGY

REDACTED VERSION

FEBRUARY 15, 2024

2021 RFP:
Post-Phase 2 Update

January 2, 2024

PUGET SOUND ENERGY

SHADED INFORMATION IS DESIGNATED AS HIGHLY CONFIDENTIAL PER WAC 480-07-160

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2021 RFP: POST-PHASE 2 UPDATE

SECTION 1. INTRODUCTION AND BACKGROUND

1. Introduction and Background

The purpose of this document is to provide an update on Puget Sound Energy's ("PSE" or the "Company") 2021 All-Source RFP (2021 RFP) since negotiations began in December 2022. The RFP process is guided by rules set forth in Washington's Administrative Code Chapter 480-107, also known as the Purchases of Resources Rules, and guidance from the Company's most recent Integrated Resource Plan (IRP) or Electric Progress Report (EPR).

PSE presented its 2021 RFP short list to its Energy Management Committee (EMC) in October 2022 and its Board of Directors in November 2022. The short list was designed to help meet PSE's Clean Energy Transformation Act (CETA) clean energy need in 2025-2026 and capacity need through 2027. The short list consisted of 12 projects from 10 developers with nameplate capacity for renewable projects of approximately [redacted] MW and nameplate capacity for pure play storage facility projects, such as standalone battery energy storage systems (BESS) and pumped storage hydro (PSH), of approximately [redacted] MW. Table 1 is the 2021 All-Source RFP short list, which also includes three proposals selected from the 2022 Distributed Energy Resources RFP.

Table 1. ***2021 RFP short list***

All-Source RFP Short List

Line	COD	Resource Type	Offer ID	Project Name	Term (Years)	Begin Year	Offer Capacity (MW)	Peak Contribution 2027_08 (MW)	Peak Contribution 2027_12 (MW)	CETA Contribution 2025 (MWh)	CETA Contribution 2026 (MWh)
1	12/1/2024	SOLAR	7621	[redacted]							
2	12/31/2024	SOLAR	8652								
3	12/31/2024	SOLAR	9015								
4	12/31/2024	SOLAR	2899								
5	3/9/2025	HYDRO	5438								
6	10/5/2025	WIND	1573	VANTAGE WIND	15	2025	90	[redacted]	1		
7	10/31/2025	BESS	7418								
8	12/1/2025	WIND	2958								
9	12/1/2025	Hybrid/Solar	1627								
10	12/1/2025	Hybrid/BESS	1627								
11	12/1/2025	BESS	5684								
12	10/31/2026	BESS	9851								
13	12/31/2026	PSH	1810								
14	DER RFP Short List										
15	1/1/2023	DER	8918								
16	1/1/2023	DER	5247								
17	1/1/2023	DER	1714								
18											

In addition, PSE named 450 MW of renewables and 450 MW of BESS as backup projects to hedge against contracting risks and provide strategic flexibility for changes to PSE's resource need. Table 2 is the All-Source RFP backup list that PSE presented to its EMC and its Board of Directors.

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Table 2. ***2021 RFP backup list***

Line	ID	Proposal Name	Highlights	Purpose
	Proposals / Offers to backup shortlist*			
1	4101		[redacted]	Backup battery project
2	9696			Backup solar project
3	1413			Backup wind project
4	3971/ 4091			Backup wind project
5	7508			Backup battery project

After presenting the short list, the Resource Acquisition team became aware of substantial increases to its forthcoming need forecasts and material changes to its shortlisted and back up listed bids. This report describes the factors that led PSE to re-evaluate its resource alternatives in the 2021 RFP. It also describes the methodology and updated assumptions used in the analysis, the modeling results, and PSE's approach to prioritizing its resource acquisition decisions to help meet the Company's resource needs at the lowest reasonable cost.

2. Status of Short List and Backup List Resources

Soon after presenting the short list to PSE's board of directors, the Resource Acquisition team learned that the forthcoming 2023 EPR would demonstrate a substantial increase in PSE's forecast clean energy and capacity needs (see Section 3). As a result, in consultation with PSE's EMC, Board of Directors and independent evaluator, PSE decided to pursue both the short list and backup list resources to support meaningful progress toward meeting PSE's CETA goals.

As negotiations progressed, PSE became aware of changes to a number of shortlisted and backup listed bids, including updated pricing and terms. Due diligence conducted by PSE during this period revealed certain substantial material risks that caused PSE to pause and later stop negotiations for four projects. Additionally, three bids were withdrawn from consideration by bidders: [redacted] and [redacted] These changes prompted PSE to re-evaluate its resource alternatives, as required by the Purchases of Resources rules:

> WAC 480-107-075(4). If a bidder makes material changes to its bid after bid ranking, including material price changes, the utility must suspend contract finalization with that bidder, and the utility and any independent evaluator must re-rank bids according to the revised bid. If the material changes cause the revised bid to rank lower than bids the utility has not originally selected, the utility must instead pursue contract finalization with the next highest ranked bid.

Tables 3 and 4 summarize the status of each short list and backup list resource from the 2021 RFP as of October 2023, just prior to PSE conducting updated optimization analysis in November.

Table 3. ***2021 All-Source RFP Short list resources status update prior to re-evaluation***

Resource Type	Offer ID	Project Name	Developer/ Sponsor	Status as of October 2023 (green fill indicates inclusion in Nov 2023 optimization)
Solar	7621	[redacted]		
Solar	8652			
Solar	9015			
Solar	2899			
Hydro	5438			
Wind	1573			
BESS	7418			
Wind	2958			
Hybrid/ Solar	1627			

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SECTION 2. STATUS OF SHORT LIST AND BACKUP LIST RESOURCES

Resource Type	Offer ID	Project Name	Developer/ Sponsor	Status as of October 2023 (green fill indicates inclusion in Nov 2023 optimization)
Hybrid/ BESS	1627	[redacted]		
BESS	5684			
BESS	9851			
PSH	1810			

Table 4. *2021 All-Source RFP backup list resources status update prior to re-evaluation*

Resource Type	Offer ID	Project Name	Developer/ Sponsor	Status
BESS	4101	[redacted]		
Solar	9696			
Wind	1413			
Wind	3971/ 4091			
BESS	7508			

PSE included ten of the short list and backup list resources in the November 2023 updated optimization analysis (indicated with green fill in tables 3 and 4). However, two of the nine [redacted] and [redacted] ere withdrawn by the bidder due to development delays right around the time PSE conducted the analysis.

PSE also conducted an interim optimization analysis in July 2023. The interim analysis included all ten of the resources included in the November update, and also included one additional project, [redacted] which PSE later eliminated due to a substantial material risk (or fatal flaw) associated with community concerns about the project's proposed siting next to a middle school.

[1] *PSE initially made a portion of its LSR development rights available to bidders through the All-Source RFP and selected the two most favorable offers as backup list alternatives. Subsequent to selecting the short list, PSE determined that a larger LSR expansion project may offer valuable economies of scale. PSE issued an RFP for an LSR expansion project up to 640 MW in May 2023. PSE is evaluating the bids in a manner consistent with the methodology established in the All-Source RFP.*

3. Increasing Resource Needs

Subsequent to identifying the All-Source RFP short list in November 2022 and soon after negotiations for the shortlisted resources began, PSE's Resource Planning team informed the Resource Acquisition team that its forecast needs for new CETA-eligible clean energy and capacity resources would be increasing in the upcoming 2023 EPR. PSE later filed the 2023 EPR with the Washington Utilities and Transportation Commission (WUTC) on March 30, 2023.[2]

PSE's 2023 EPR identified an increased need for new clean energy resources

CETA requires Washington utilities to meet at least 80% of electric sales (as measured by delivered load) using non-emitting or renewable resources by 2030, and 100% of sales by 2045. Table 5 presents the evolution of the RFP clean energy need in 2026, beginning with the need presented in the 2021 RFP filing[3] through re-evaluation work conducted during negotiations.

Because PSE was still developing its CETA need forecast for the 2023 Electric Progress Report at the time the RFP Phase 2 evaluation was conducted, PSE used the December 2021 CEIP need for the analysis used to select the RFP short list. PSE later updated to the 2023 EPR clean energy need for its post-Phase 2 re-evaluation analysis conducted during the negotiation phase. These updates resulted in a need increase of nearly 79% since the 2021 RFP was approved.

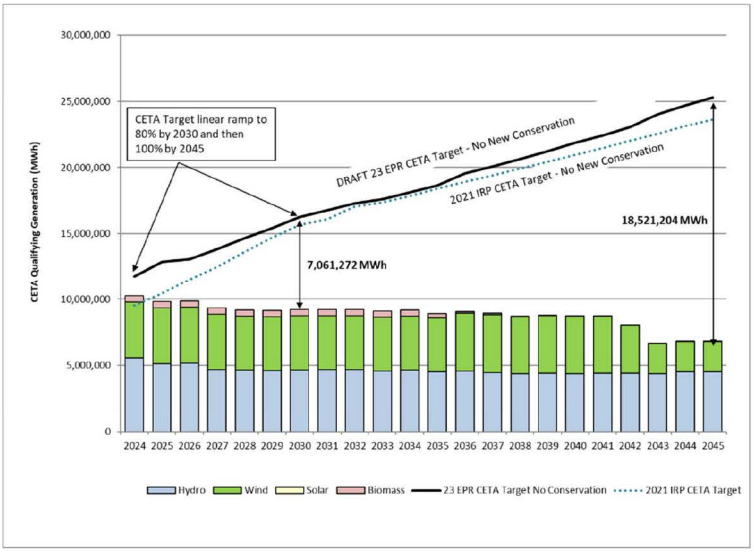
Table 5. ***Evolution of 2021 All-Source RFP clean energy need forecast***

	Filed 2021 RFP *April 2021 IRP* *(F2020 load forecast)*	RFP Phase 2 *December 2021 CEIP* *(F2021 load forecast)*	Post-Phase 2 *March 2023 EPR* *(F2022 load forecast)*
Clean energy need in 2026	1,669 GWh	2,625 GWh	2,982 GWh

Figure 1 illustrates PSE's projected need for renewable and non-emitting energy as reported in the 2023 EPR. The forecast assumes a linear ramp to achieve the CETA standards in 2030 and 2045; however, actual resource acquisitions through implementation of PSE's Clean Energy Implementation Plan (CEIP) will likely produce less linear results. The 2023 IRP EPR estimates that PSE will need to add more than 7 thousand GWh of non-emitting/renewable energy to meet the 80% clean energy standard in 2030.

[2] *PSE's CETA clean energy and capacity needs are calculated consistent with WAC 480-100-620.*
[3] *The RFP identified a need for 1,669 GWh of new CETA-eligible clean energy resources by 2026 growing to 5,369 GWh by 2030, and a need for 369 MW of new electric capacity resources in 2026 increasing to 527 MW in 2027.*

Figure 1. ***CETA clean energy need***



For more information about PSE's clean energy needs, see chapters 7 and 8 of the 2023 EPR.[4]

PSE's 2023 EPR identified an increased need for new capacity resources

The 2021 RFP identified two types of capacity need. The first type is a forecast of the amount of perfect capacity PSE must add to meet a loss of load probability (LOLP) target of 5%. The second type is the additional peak capacity need that would result from PSE reducing its reliance on Mid-Columbia (Mid-C) market purchases. PSE currently relies on up to 1,500 MW of Mid-C short-term market purchases paired with existing PSE transmission rights to help meet demand.

The western energy market has had surplus capacity for more than a decade. Given PSE's available firm transmission to the Mid-C market hub, purchasing energy supply from the regional power market has been a cost-effective way to meet demand and past IRPs have treated the ability to buy Mid-C energy as 100% reliable. However, the supply and demand fundamentals of the wholesale electric market have changed significantly in recent years in two important ways: supplies have tightened and pricing volatility has increased. Additionally, PSE's planning process now reflects that such purchases, contracted under WSPP Schedule C, can be settled with financial liquidated damages and do not provide the same reliability as a resource-specific contract or ensure that actual generation is allocated to the transaction. This represents a reliability risk to PSE. To help address this risk, PSE plans to reduce its reliance on short-term market supplies.

[4] *Puget Sound Energy, "2021 Integrated Resource Plan," issued April 1, 2021, https://www.pse.com/en/IRP/Current-IRP-Process. See Chapter 8, Electric Analysis.*

Because PSE was still developing its capacity need forecast for the 2023 EPR at the time the RFP Phase 2 evaluation was conducted, PSE used the draft EPR capacity need. The draft EPR need did not yet reflect increases associated with a reduction in PSE's market reliance, nor did it reflect new conservation numbers that were still being developed. PSE updated to the final 2023 EPR need for its RFP post-Phase 2 analysis. Table 6 presents the evolution of the RFP capacity need for 2027, beginning with the need presented in the approved 2021 RFP through re-evaluation work conducted during negotiations. Because the peak capacity need numbers no longer treat market reliance separately from the peak capacity need, PSE's 2023 EPR is forecasting capacity need in winter 2027 that is considerably higher than the peak capacity need the RFP solved for at the end of Phase 2, which was itself an increase to the capacity need forecast in the approved RFP.

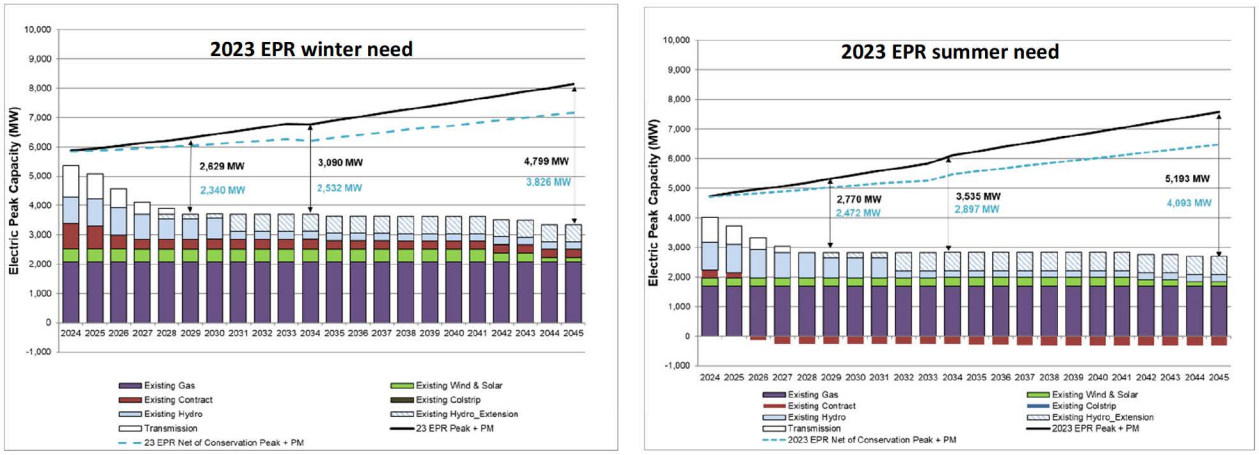
Table 6. ***Evolution of capacity need forecast in 2027 during the 2021 All-Source RFP***

	Approved 2021 RFP *April 2021 IRP (F2020 load forecast)*	RFP Phase 2[5] *2022 Draft EPR (F2022 load forecast)*	Post-Phase 2 *March 2023 EPR (F2022 load forecast)*
Peak capacity in 2027 – winter	527 MW	~ 750 MW	1,848 MW
Peak capacity in 2027 – summer	n/a	~ 1,000 MW	1,906 MW

The 2023 EPR determined a peak hour capacity need with a resource adequacy analysis that evaluated existing PSE resources compared to the projected peak need over the planning horizon. The capacity shown is the amount of effective capacity needed to maintain the resource adequacy target — the need after applying the effective load carrying capacity ("ELCC") of different resources. Due to market reliance assumptions used in the 2023 EPR, the modeling indicates that PSE could begin to experience a peak capacity shortfall starting in 2024. Before any conservation, the peak capacity need plus the planning margin required to maintain reliability is 2,629 MW by 2029. Net of conservation — the peak capacity need plus the planning margin for winter and summer — are 2,340 MW and 2,472 MW. These figures represent the difference between the load forecast (the demand forecast plus the required planning margin), and the total peak capacity credit of existing resources. Figure 2 shows the winter and summer peak capacity needs through 2045.

[5] *The Draft EPR need included climate change analysis in the F2022 and the EPR planning reserve margin. It did not yet reflect EPR conservation or market reliance reduction assumptions. PSE used 2021 IRP conservation as a proxy.*

Figure 2. ***Peak capacity need – winter and summer***



For more information about PSE's peak capacity needs, see Chapter 8 of the 2023 EPR.[6]

[6] *Puget Sound Energy, "2021 Integrated Resource Plan," issued April 1, 2021, https://www.pse.com/en/IRP/Current-IRP-Process. See Chapter 8, Electric Analysis.*

4. Updated Pricing for Renewable and Capacity Resources

Post-Phase 2 Solar and Wind Updates

In March 2023, PSE requested updated pricing from RFP bidders of certain wind and solar resources that were not originally selected to the short list or backup list. The following factors triggered this request:

1. The increase in clean energy and capacity need identified in the 2023 Electric Progress Report.

   See tables 5 and 6, and figures 1 and 2 above.

2. Changes and updates to the short list and backup list:

   See tables 3 and 4 above.[7]

   a. Withdrawal from the RFP by two solar and one wind resource totaling 297 MW:
      i. [redacted] short list), 160 MW with 2024 COD
      ii. [redacted] (short list), 41 MW with 2024 COD
      iii. [redacted] short list), 96 MW with 2025 COD

   b. Removal of 300 MW [redacted] short list) from the RFP process due to a lack of visibility and potential fatal flaw with the transmission plan.
      i. A new BPA process decision (if any) to create new scheduling point on the Northwest AC Intertie anticipated end of September 2023 at the earliest. PSE and [redacted] continuing bilateral discussions on alternative transaction structures tied to resolution of transmission obstacle.

   c. Price increases from the following resource proposals:
      i. [redacted] short list)
      ii. [redacted] (short list)
      iii. [redacted] backup list)

   d. Removal of the 140 MW [redacted] backup list) from the 2021 All-Source RFP process, and invitation to bid in a new targeted RFP for the larger LSR wind resource area issued in May 2023.

To identify projects that would merit a request for a price update and potential re-activation for updated optimization analysis, PSE revisited all CETA-eligible clean energy generating projects from Phase 1 and Phase 2 that had not been selected for the short list or backup list, and that had not withdrawn or been

[7] *Changes and updates in the bullet list above reflects adjustments to the short list and backup list as of March 2023. Additional resources were later either eliminated due to substantial material risks (or fatal flaws), or withdrawn from consideration by bidders. See tables 3 and 4 for the status of all short list and backup list resources just prior to the updated optimization analysis conducted by PSE in November 2023.*

disqualified due to a fatal flaw. PSE prioritized projects that presented the lowest deliverability risk and did not present any known material or substantial commercial risks. The Resource Acquisition team then worked with relevant PSE subject matter experts (SMEs) to assess these projects for potential reactivation based on two criteria:

1. Transmission Feasibility: First, PSE looked for projects that presented a clear path to deliver the resource's output to PSE's eligible points of delivery (PODs). Available transmission capacity (ATC), status of transmission service requests (TSRs) and study results, dependency on transmission upgrades and timelines in BPA's cluster studies, interconnection progress and timelines, and any other relevant factors were considered.
2. Commercial Feasibility. Second, PSE looked for any material or substantial commercial or qualitative risks, or fatal flaws. PSE considered its risk assessments in the Phase 2 due diligence as well as the Phase 1 qualitative evaluation, and requested updates where needed from the project bidders in key areas, including site control, permitting, project design and major equipment procurement status.

Those projects with transmission plans that were assessed as "feasible today" (i.e. having available ATC and/or a clear path to delivery) and that also did not present any known substantial material commercial risks or fatal flaws were asked to provide renewed pricing. Table 7 summarizes the results of PSE's review.

Table 7. ***RFP clean energy projects considered for reactivation in the July 2023 interim optimization analysis (reactivated projects indicated in green)***

Proposal ID	RFP Phase	Project	Developer/ Sponsor	Location	Technology	Nameplate	Transmission Assessment	Material/Substantial Commercial Risk or Fatal Flaw Identified?	Project Update Requested?	Price Update?	LCOE (busbar)	LCOE (incl TX)
3345	1	[redacted]										
5684	1											
2807	1											
6518	1											
7103	2											
7374	1											
7405	1											
3947	1											
2351	1											
1524/3325	2											
1524/8150	2											
1524/3325	2											
8150	2											
8051	2											
2725	2											
5088	2											
5864	1											
9374	1											

2021 RFP: POST-PHASE 2 UPDATE

SECTION 4. UPDATED PRICING FOR RENEWABLE AND CAPACITY RESOURCES

Proposal ID	RFP Phase	Project	Developer/ Sponsor	Location	Technology	Nameplate	Transmission Assessment	Material/Substantial Commercial Risk or Fatal Flaw Identified?	Project Update Requested?	Price Update?	LCOE (busbar)	LCOE (incl TX)
6549	1	[redacted]			Solar	[redacted]	Challenging	No (subject to further DD)	y	n		
6430	1				Wind		Challenging	No (subject to further DD)	y	n		
6185	1				Solar		Challenging	No (subject to further DD)	y	n		
3060	1				Solar		Challenging	No (subject to further DD)	y	n		
3155	1				Solar		Challenging	No (subject to further DD)	y	n		
5056	1				Solar		Challenging	No (subject to further DD)	n	n		
5703	1				Solar		Challenging	No (subject to further DD)	n	n		
3180	1				Wind		Challenging	No (subject to further DD)	n	n		
2892	2				Solar		Challenging	Yes	n	n		
3028	1				Wind		Challenging	No (subject to further DD)	n	n		

PSE routinely conducts ongoing due diligence as part of contract negotiations to evaluate commercial risks. PSE sent data requests and engaged with the bidders of projects with "feasible today" transmission plans in order to identify any known risks that could forestall a request for a price update.

Five solar and one wind project met both criteria and provided updated pricing.[8] PSE looked for price competitiveness on a levelized cost of energy (LCOE) basis compared to other resources still under active consideration or negotiation, as well as suitability as a replacement resource of a similar type to those that had fallen out of the RFP short list and backup list. PSE included all six of these resources in interim Aurora modeling conducted in July 2023 that incorporated updated energy and capacity needs identified in the 2023 EPR. PSE also included all six reactivated proposals in the November updated optimization analysis. See also Section 6, Table 11 for a complete list of the resources evaluated in the November updated optimization analysis.

Post Phase 2 Battery Storage Updates

In March 2023, PSE requested updated pricing from RFP bidders of battery storage resources that were not originally selected to the short list or backup list. The following factors triggered this request:

1. The increase in capacity need identified in the 2023 Electric Progress Report.
    i. See Table 6, and Figure 2 above.
2. Changes and updates to the short list and backup list:
    ii. See tables 3 and 4 above.

[8] *The bidders of two projects with "feasible today" transmission assessments* [redacted] *informed PSE that their projects were off the market.*

a. Paused consideration of 200 MW [redacted] (short list) from the RFP process due to a substantial material risk or potential fatal flaw with siting.

i. Project is located near a middle school. [redacted] ouncil and local community representatives have expressed concern and opposition to project due to its proximity to the school.

b. Removal of 250 MW [redacted] backup list) from the RFP process due to a substantial material risk or potential fatal flaw associated with interconnection feasibility uncertainties.

ii. [redacted] oratorium caused the bidder to change its project site. Interconnection cost and timeline for the new [redacted] site are unknown. Project will need a new substation and POI change.

a. Price increases from the following resource proposal:

iv. [redacted] backup list)

[redacted] provided a revised pricing structure for its backup listed [redacted] oll on March 7, 2023 that materially changed its best and final offer (BAFO) price previously provided on July 22, 2022 and later confirmed on August 26, 2022. The new pricing increased [redacted] toll from [redacted] kW-yr to an indexed toll pricing structure, ranging between [redacted] to [redacted] W-yr (indexed to lithium carbonate prices). On average, [redacted] new pricing represented a [redacted] increase above their evaluated price.

PSE determined which developers to contact by revisiting the battery storage ranking list and selecting those proposals that had neither withdrawn nor been disqualified due to a substantial material risk or fatal flaw, and whose last received BAFO tolling price was either similar to or less than the upper end of [redacted] new tolling pricing bracket. In addition, to consider resources with similar storage capabilities to [redacted] only standalone batteries located on PSE's system were considered. For qualitative reasons, to avoid single developer risk, two [redacted] rojects, [redacted] that would have otherwise been included in the refresh, were excluded for the aforementioned qualitative reason.

In total, seven developers were contacted and asked to provide an update on the commercial availability of their proposals, any new project updates since communications last occurred, and any changes, if any, to their BAFO pricing.

Table 8. ***RFP bidders asked to refresh their pricing (shown in green)***

Proposal ID	Project name	Developer	COD	Nameplate (MW)	Capacity price ($/kW-yr)	Status and notes
3387	[redacted]	[redacted]	7/1/2026	[redacted]	[redacted]	[redacted]
9439			7/1/2024			
2841			12/1/2025			
2889			12/1/2025			
5999			9/30/2025			
1054			12/31/2026			
4644			12/31/2025			
9788			12/31/2025			
8179			12/31/2025			
9136			12/31/2025			
6465			10/31/2025			
5435			10/31/2025			

As shown in Table 9, PSE received responses from all seven contacted developers, including updates to the capacity pricing for all but one of the proposals [redacted] held their pricing steady. Bidders also provided COD updates for the [redacted] and [redacted] projects.

Additionally, [redacted] provided updates on the status of their respective interconnection agreements. Meanwhile [redacted] nd [redacted] provided updates on the completion of their draft Facilities Studies for interconnection.

Table 9. ***Capacity pricing and COD updates from BESS developers***

Proposal ID	Project Name	COD	COD (Updated)	Namplate (MW)	Updated Capacity Price – busbar ($/kw-yr)	Updated Capacity Price – w/transmission and interconnection upgrades ($/kw-yr)
4644	[redacted]	12/31/2026		[redacted]	[redacted]	[redacted]
2841		12/1/2026				
5999		9/30/2025	6/1/2026			
3387		7/1/2026				
9439		7/1/2024	6/30/2026			
9439		7/1/2024	6/30/2026			
1054		12/31/2025	12/31/2026			
2889		12/1/2025	12/1/2027			

PSE included five of the refreshed battery storage proposals in the interim optimization analysis conducted in July 2023 [redacted] and [redacted] were not included in the interim analysis. [redacted] was flagged in Phase 2 as having a potential substantial/material risk (or fatal flaw) due to its location in a highly impacted community. PSE offered the bidder an opportunity to provide an update on the project in March 2023, but did not receive the requested update. PSE did include [redacted] in its November 2023 updated optimization analysis, but ultimately eliminated the project from

[9] *Price shown does not reflect of 2% annual escalation factor.*

consideration based on the qualitative review. The [redacted] was originally eliminated from Phase 2, but later reintroduced after the July 2023 interim optimization analysis once a mistake in the timeline to complete interconnection was corrected in the Facilities Study. All seven projects were included in the updated optimization analysis conducted in November 2023.

5. Additional Resources Outside the RFP

PSE's re-evaluation analysis considered all active resources in its "deal pipeline". The deal pipeline is a dynamic inventory of RFP and bilateral offer opportunities available to PSE that is updated on a real time basis. Offers that PSE is currently exploring, evaluating or negotiating are considered to be "active" in the pipeline.

Table 10 is a list of non-RFP-affiliated bilateral offer opportunities that were in the deal pipeline during the RFP negotiations and re-evaluation stage. The status column indicates whether the offer was considered to be active or inactive at the time the updated optimization analysis was performed in November 2023. Where offers are identified as inactive, the reason is also summarized in the status column below.

Table 10. ***Bilateral offer opportunities considered during RFP re-evaluation***

Project	Counterparty	Resource type	Location	COD/ Term start	Nameplate Capacity (MW)	Status (Active projects included in updated optimization)
Beaver Creek Battery	Caithness	Battery (4 hr)	Montana	8/15/2025	100	Active – Included in Nov. 2023 update
Beaver Creek Wind	Caithness	Wind	Montana	3/31/2025	248	Active – Included in July and Nov. 2023 updates
[redacted]		Solar	Montana	1/1/2026	[redacted]	
		Solar	Montana	1/1/2026		
		Wind	Montana	1/1/2026		
		Wind	Montana	1/1/2026		
		Solar	Montana	1/1/2028		
		Solar	Montana	1/1/2028		
		Wind	Montana	1/1/2028		
		Wind	Montana	1/1/2028		
		Solar	Washington	12/31/2026		
		Nuclear (Small Mod Reactor)	TBD	12/31/2032		
		Natural Gas	Washington	12/31/2029		
		Solar	Montana	6/30/2026		
		Wind	Montana	6/30/2026		
		Wind	Oregon	1/1/2027		

6. Post-Phase 2 Analysis and Resource Selections

PSE uses the same models and methodology to fairly and consistently compare RFP resources and bilateral opportunities. PSE's process is described in the 2021 All-Source RFP, which was approved by the WUTC in docket UE-210220 in June 2021.

PSE documented its RFP evaluation process and results in its 2021 All-Source RFP Evaluation Process Document, which will be provided to the Board of Directors along with this memo on January 11, 2024.

Vantage PPA executed based on 2021 RFP Phase 2 analysis

In June 2023, PSE signed a 15-year power purchase agreement (PPA) with Invenergy's Vantage Wind Energy LLC to receive clean energy from its Vantage Wind Energy Center beginning in 2025. Vantage is an existing, 90 MW wind farm located in Ellensburg, Washington.

Vantage was selected for the RFP short list as part of a lowest reasonable cost solution to help meet PSE's resource needs. As an operating project with transmission to PSE's load center, Vantage offered very low risk at a competitive price. It was also the only shortlisted resource capable of contributing to PSE's 2025 interim CETA target.

Negotiations for the Vantage Wind PPA substantially concluded relatively soon after the 2021 RFP short list was selected. PSE presented Vantage to its EMC in March 2023 and Board of Directors in May 2023 and received approval from the Board to execute the PPA at that time. See also the Vantage EMC presentation dated March 30, 2023 and Board presentation dated May 11, 2023 for more information about the deal terms, risks and benefits of the Vantage.

Beaver Creek MIPA executed based on analysis completed in July and verified by analysis updated in November 2023

In September 2023, PSE executed a Membership Interests Purchase Agreement (MIPA) with Caithness Beaver Creek, LLC to purchase the Beaver Creek Wind Project development rights. MIPA closing occurred in December 2023. Beaver Creek is a utility-scale wind project located in Stillwater County, Montana with an expected commercial operation date in March 2025. The proposed project has an expected nameplate capacity of 248 MW and the development rights include real estate rights in neighboring Sweet Grass County anticipated to support 100-150 MW of future development and expansion.

Beaver Creek was selected as part of a lowest reasonable cost portfolio solution to help meet PSE's resource needs in an interim portfolio optimization analysis update conducted in July 2023. PSE's analysis compared Beaver Creek to active RFP and bilateral opportunities in PSE's pipeline at the time the analysis was conducted. At that time, PSE recognized that Beaver Creek was a time-sensitive opportunity of unique value. Beaver Creek is in a near-construction-ready state with an identified transmission solution, and a low to acceptable overall risk profile. With a COD in March 2025, it was also the only clean energy development project in PSE's pipeline capable of helping to meet PSE's 2025 interim CETA target, but only if definitive agreements could be executed in time to support the project schedule. This meant executing

the MIPA before the end of Q3 2023 and executing agreements for turbine supply and a balance of plant (BOP) contractor by roughly the end of the year.

PSE presented Beaver Creek to its EMC and Board of Directors in August 2023 and received approval to execute the MIPA at that time. PSE later sought approval from the EMC and Board of Directors in November 2023 to execute the Turbine Supply Agreement and BOP Agreement at or shortly after the MIPA closing in December. Prior to closing, PSE updated its optimization analysis in November, which reaffirmed the selection of Beaver Creek as part of a lowest reasonable cost portfolio solution to meet the Company's growing clean energy and capacity needs.

See attachments B and C for detailed reports describing the updated optimization analysis conducted in July and November 2023. See also the Beaver Creek reports presented to the Board of Directors on August 3, November 2 and November 29, 2023 for more information about the deal terms, supporting analyses, risks and benefits of the Beaver Creek Wind Project.

Additional anticipated acquisitions based on analysis completed in November 2023

PSE conducted updated portfolio optimization modeling of all active resources in its deal pipeline in November 2023. Table 11 is the list of proposals included in the updated analysis.

Table 11. ***Resource alternatives included in Nov. 2023 updated optimization analysis***

Type	ResourceName	Nameplate	COD
BESS	[redacted]		12/31/2026
BESS			12/1/2025
BESS			12/1/2026
BESS			12/1/2026
BESS			12/1/2027
BESS			7/1/2026
BESS			12/31/2025
BESS			12/31/2026
BESS			12/1/2026
BESS			6/1/2026
BESS	Beaver Creek Battery	100	8/15/2025
BESS	[redacted]		6/30/2026
BESS			6/30/2026
BESS			10/31/2026
Solar			6/30/2026
Solar			6/30/2026
Solar			12/31/2026
Solar			12/1/2026
Solar			12/1/2027
Solar			12/31/2027
Solar			12/31/2025
Solar			12/31/2026
Solar			6/30/2026
Solar			12/31/2026
Wind			12/31/2027
Wind			12/31/2027
Wind			12/31/2028
Wind	Vantage Wind	90	10/5/2025
Wind	[redacted]		12/31/2027
Wind	Beaver Creek Wind	248	3/31/2025
Wind	[redacted]		6/30/2028
Wind			6/30/2026
Wind			1/1/2027

Type	ResourceName	Nameplate	COD
Hybrid/BESS	[redacted]		12/31/2027
Hybrid/BESS			6/30/2026
Hybrid/BESS			6/1/2027
Hybrid/BESS			12/1/2027
Hybrid/Solar			12/31/2027
Hybrid/Solar			6/30/2026
Hybrid/Solar			6/1/2027
Hybrid/Solar			12/1/2027
Hydro			3/9/2025
Pumped storage			12/31/2030
Pumped storage			12/31/2030
Biodiesel			10/31/2025
Biodiesel			10/31/2026
Biodiesel			10/31/2026
DER			2023
DER			2023
DER			2023

Optimization modeling assumptions and approach

PSE updated its Aurora portfolio model to incorporate assumptions generally consistent with the 2023 EPR, including the 2023 EPR clean energy and capacity need forecasts described in Section 3. PSE also updated the model to reflect the most current individual offer pricing and terms available to PSE at the time the analysis was conducted (shown in Section 4).

At a high level, PSE created a reference portfolio and tested the robustness of the resource selection decisions in a series of sensitivities. PSE used the Aurora portfolio model to first identify the least-cost set of resource alternatives from the list of resources under consideration. This initial reference case was then used as the starting point for a series of sensitivities to estimate the portfolio benefit of several, potentially high-priority resource alternatives. The portfolio benefits were estimated by removing each such resource as an alternative and then running Aurora without that alternative. This approach allowed PSE to estimate the value of each individual resource over a variety of time horizons, to better understand how valuable each individual resource would be to the portfolio. This is important for a variety of reasons, including understanding whether resources have significant value relative to each other, and if they are very close in portfolio value. Additionally, this approach identifies the next-best alternative, should the specific resource studied end up being unavailable. The same approach was also used for some resources that did not appear in the Aurora-generated reference portfolio to demonstrate how far out of the money a particular resource might be, as some resources not selected in the reference case may have been within rounding error.

Optimization results and selection decisions

Given the magnitude of PSE's need, the Aurora model is selecting most of the available resources in PSE's alternatives pipeline. Table 12 presents a summary of the results of the updated optimization analysis conducted in November 2023. See also Attachment C for the specific resource selections associated with each of the sensitivity runs.

Table 12. ***Updated Optimization Results Summary (November 2023)***

Resource Type	Name	Nameplate Capacity (MW)	Reference	# Times selected (out of 28)	COD	Total Portfolio Costs WITH RFP Offer ($Billions)	Total Portfolio Costs WITHOUT RFP Offer ($Billions)	Cost/(Benefit) ($Billions)	Cost/(Benefit) per Nameplate $Millions/MW	% Change	Location
BESS	Beaver Creek Battery	100	Y	26	8/15/2025	[redacted]					Stillwater, MT
BESS	[redacted]		Y	27	12/31/2025						
BESS			Y	27	12/31/2026						
BESS			Y	27	10/31/2026						
BESS			Y	27	12/1/2027						
BESS			Y	24	12/1/2026						
BESS			Y	27	7/1/2026						
BESS			Y	27	12/1/2026						
BESS			Y	26	12/31/2026						
BESS			Y	27	6/1/2026						
Solar			Y	27	12/31/2025						
Solar			Y	19	6/30/2026						
Solar			Y	16	6/30/2026						
Solar			N	6	12/31/2026						
Solar			N	6	6/30/2026						
Wind	Beaver Creek Wind	248	Y	27	3/31/2025						Stillwater, MT
Wind	[redacted]		Y	24	12/31/2027						
Wind			Y	27	6/30/2026						
Wind			Y	20	6/30/2028						
Hybrid/BESS			N	1	6/1/2027						
Hybrid/BESS			Y	24	12/31/2027						
Hybrid/BESS			Y	23	12/1/2027						
Hydro			Y	27	3/9/2025						
Biodiesel			Y	27	10/31/2025						

However, it would be infeasible for PSE to pursue negotiations with all of the selected resources in the current RFP cycle. To address this, PSE developed a recommended approach to prioritize and pursue the most attractive, commercially-ready projects and focus on those that appeared to be executable between the end of 2023 and the end of Q1 2024. There are several benefits to this approach.

1. PSE will be able to make meaningful progress now while signaling to developers with later project CODs that there will be another opportunity for their projects to be considered in the 2024 RFP.
2. PSE will have an opportunity to conduct market outreach, identify projects that are not currently in PSE's project pipeline and encourage them to participate in the process.
3. PSE intends to provide new guidelines in the 2024 RFP that will establish timelines for project and price updates, which would allow for better alignment of projects, pricing and contract execution.
4. Proposed approach and timeline to complete the current RFP at or about the end of Q1 2024 will allow PSE to reset and develop a new 2024 Voluntary All-Source RFP, which can begin earlier in 2024 and follow an expedited timeline.

PSE's prioritization approach began with the pool of resources selected in the model. PSE then considered five key factors (shown in Table 13) to determine which resources would be prioritized for negotiation this RFP cycle.

Table 13. ***Key factors used to prioritize model-selected resources for negotiation***

Factors	Considerations
COD	• Prioritize nearest term (COD) and most beneficial projects (LCOE, Portfolio Benefit) • Preserve ability to evaluate later COD projects through next RFP while minimizing impact to projects schedules and achievement of CETA and capacity targets
LCOE	
Portfolio Benefit	
Commercial Readiness	• Minimize project risks associated with timing, costs and project feasibility to support lowest reasonable cost portfolio decisions
Qualitative Risk	

PSE has identified the following resources for prioritized negotiation, which align well with the factors shown in Table 13 and resources selected in the CBI sensitivity, present opportunities of unique value to PSE, and have a high likelihood of executing quickly in Q1 2024. These resources include the [redacted] and two or three battery storage projects.

- [redacted] **(ID #7621)** [redacted] is a 142 MW, solar development project located in [redacted] Washington. The offer proposes a sale of the development rights to PSE, which [redacted] would continue to develop and construct under an engineering, procurement and construction contract; and includes rights to expand the solar project and add battery storage to the site in the future. The project is in a near-construction-ready state with a target COD in December 2025.

[redacted] is competitively priced and was selected as part of a lowest reasonable cost portfolio solution in the updated optimization analysis conducted in November 2023. The project offers valuable resource diversity to PSE's wind-rich clean energy portfolio[redacted] is well-developed with a lower overall risk profile than alternatives, and will be able to leverage neighboring LSR wind farm interconnection and transmission rights, and existing operations, communications, roads and infrastructure[redacted] will build the project using domestically-produced solar panels to meet IRA domestic content guidelines.

- [redacted] **(ID #1413) -** [redacted] is a 315 MW, wind development project located in [redacted] Montana. The offer proposes a 25-year PPA under which PSE would receive as-generated wind energy and attributes from the [redacted] The project has a target COD of December 2027.

  [redacted] offers the highest net capacity factor (NCF) and most competitive pricing among all renewable resource options in PSE's pipeline. The Project was selected as part of a lowest reasonable cost portfolio solution in the updated optimization analysis conducted in November 2023. [redacted] will utilize PSE's existing transmission rights on the Colstrip Transmission System and BPA transmission system, sharing and optimizing this transmission capacity with generation from the existing Clearwater Wind facility and other planned Montana projects when Colstrip Units 3 & 4 are discontinued by the end of 2025. PSE's analysis shows tha[redacted] wind profile complements those of Clearwater Wind and the planned 232 MW Beaver Creek Wind Project.

- **BESS projects – counterparties TBD:** PSE will also pursue two to three on-system battery storage projects. The Resource Acquisition team is currently reviewing alternatives selected in the November 2023 updated optimization analysis to determine which proposals to prioritize this RFP cycle.

Additional resources may be considered for prioritization, if opportunities of unique or time-sensitive value are identified and can be executed in a timely manner, or if negotiations between PSE and one or more of the counterparties above are unsuccessful. PSE will more fully describe the rationale for individual resource selections in reports to its EMC and/or Board of Directors prior to executing contracts.

See Attachment C for a detailed report describing the November 2023 updated optimization analysis and results.

Financial analysis

During the post-Phase 2 period of the 2021 RFP, PSE also conducted an ownership versus PPA analysis of seven projects with both a PPA and an ownership option. PSE used the PPA Ownership Evaluation Model (POEM) developed by consultant Thorndike Landing to perform this analysis. The model calculates the following relative costs and benefits to PSE customers over a defined timeframe under each commercial structure

Table 14. ***Costs and benefits calculated by the PPA Ownership Evaluation Model***

For owned assets	For PPAs
• Expected capital costs • Operating costs including property tax and insurance • Tax incentives • Financing costs • Integration and Transmission upgrade costs • Expected residual value	• Expected cost of power purchased under proposed PPAs • Impact of debt imputed under long-term contracts • Replacement resource costs of post PPA period (if applicable)

This allowed PSE to compare the levelized cost of each structure for each of the seven projects. Attachment D describes the POEM model and modeling approach in greater detail, and provides a table showing the results of the analysis.

7. Independent Evaluator

The WUTC adopted new Purchases of Resources rules (WAC 480-107) in December 2020 that introduced a requirement for an independent evaluator (IE). The IE seeks to ensure a fair, transparent and proper RFP process. After conducting an RFP solicitation for an IE and receiving WUTC approval in docket UE-210037 on January 28, 2021, PSE engaged Bates White to be the IE for the 2021 RFP.

The IE's duties and responsibilities ranged from participating in the design of the 2021 RFP, to verifying that PSE's inputs and assumptions were reasonable and independently assessing whether PSE's selection of resources was reasonable. PSE involved and informed the IE throughout the RFP evaluation and negotiations processes. This involvement included regular meetings, correspondence and information sharing on evaluation and negotiations progress and results. PSE consulted with the IE on process questions, project selections and eliminations, and a variety or other key issues to ensure fairness, transparency, and alignment with RFP requirements and the Purchases of Resources rules.

Throughout the negotiation and post-shortlist re-evaluation period, PSE kept the IE engaged with periodic updates on our progress. PSE included Bates White in its negotiation meetings with counterparties, shared bid updates, provided briefings on new comparative analysis results and findings uncovered as part of PSE's ongoing commercial risk assessment, and shared our thinking at decision points. PSE routinely sought feedback from the IE on its approach to the analysis and decision-making, and worked with the IE to reconcile any differences.

The IE's role is further discussed in Appendix C to the 2021 RFP Evaluation Document, which will be provided separately to the Board of Directors on January 11, 2024.

8. Next Steps

PSE intends to wrap up its 2021 RFP as expeditiously as possible. To that end, the Company has targeted the end of Q1 2024 to substantially complete negotiations with selected counterparties.

Over the next three months, PSE will negotiate with counterparties for prioritized projects from the November 2023 updated optimization: th [redacted] and two to three BESS projects. PSE will also consider whether additional resource acquisitions are feasible and executable during the current RFP cycle.

PUGET SOUND ENERGY

2021 RFP: Post-Phase 2 Update

Attachment A. Interim Updated Optimization Analysis

July 2023

2021 ALL–SOURCE REQUEST FOR PROPOSAL

MODELING UPDATES AND DRAFT RESULTS INCLUDING BEAVER CREEK ANALYSIS

July 26, 2023

PUGET SOUND ENERGY

Contents

1. Introduction and Key Assumptions

The objective of this document is to describe the modeling assumptions, methods and results used to support modeling for the 2021 All-Source Request for Proposal (2021 RFP) including Beaver Creek. The modeling framework builds upon previous analytical work completed for the 2021 RFP and 2023 Electric Progress Report (2023 EPR).

PSE filed the 2023 Electric Progress Report with the Washington Utilities and Transportation Commission on March 31, 2023. The 2023 EPR provides a two-year progress report on the 2021 IRP as required by Clean Energy Transformation Act (CETA). The assumptions and documentation of the 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. The 2023 EPR Preferred Portfolio serves as a starting point for the 2021 RFP Analysis including Beaver Creek.

For the purposes of this study including Beaver Creek, we created a reference portfolio and then tested sensitivities from the reference. The portfolios tested in the analysis are

1. Reference [redacted] W nameplate limit on resources from Montana including Clearwater and all RFP with commercial online as stated from bid
2. Reference without Beaver Creek
3. Reference + change in start date for [redacted]
4. Reference + Montana nameplate limit increased to [redacted] MW including Clearwater
5. Reference + change start date fo [redacted] Montana nameplate limit increased to [redacted] W including Clearwater
6. Reference + delay start date for Beaver Creek to 2026

2. Updates to the 2023 EPR Preferred Portfolio Aurora Model

As part of this analysis, we made several updates to the 2023 EPR Preferred Portfolio Aurora Model in order to evaluate new resource offers received through the 2021 RFP and bi-lateral channels. This section describes the changes to the Aurora Model.

2.1. Aurora Version

The 2023 EPR utilized Energy Exemplar's Aurora Model version 14.1.1036 in developing the Preferred Portfolio. Since then, Energy Exemplar released Aurora version 14.2.1059 which we adopted for this analysis. Some of the benefits of Aurora version 14.2.1059 include improvements to energy storage modeling and reduction to the runtime of the study. Benchmarking tests on the 2023 EPR Reference Portfolio between the two Aurora versions reflect a decrease in portfolio costs and minor changes in overall builds including a slight shift to slightly more solar + battery hybrid, while significantly improving model run time.

Table 1.1 Benchmarking 2023 EPR Reference Portfolio Costs, 2024–2045 NPV ($ Billions)

2023 EPR Reference Portfolio	Portfolio Cost ($)	SCGHG Costs ($)	Total ($)	Change from v14.1 ($)	Change from v14.1 (%)
Aurora version 14.1.1036	17.61	3.24	20.85	0.00	-
Aurora version 14.2.1059	17.66	3.18	20.84	-0.01	0.00

2.2. Project Setup

Several updates were made to the Aurora project settings in order to be consistent with the setup from earlier analyses including:

- Move the study period End Date to finish in 2045 instead of 2047
- Adjust the dispatch week sampling schedule of the LTCE simulation to sample the 1st and 3rd weeks of the month instead of the 2nd week of the month
- Uncheck the Remove Penalty Adders from Pricing to limit the influence of penalties on the simulation solution
- Check the Use Capacity Price Table as an input with zero as the capacity value for resources to limit the influence of AURORA's capacity price calculation on simulation solution
- Change the parallel processing setup to use maximum parallel solves of 5 and parallelized across 4 years to improve run time and maintain simulation consistency

2.3. Input Tables

This section briefly summarizes the changes made to the Aurora Input tables for this analysis.

Constraint: The constraint table reflects the long-term capacity maximum values for generic new resources used to limit the nameplate additions by resource categories. This table works in conjunction with the generic resource records in the New Resources table. We updated the capacity limits (megawatts; MW) for generic new resources in this analysis to account for the selection of RFP offers prior to the selection of generic new resources. More information on the generic new resources Effective Load Carrying Capability (ELCC) tranche adjustments is available section 2.4.1 ELCC Tranches.

Custom Constraint and Constraint Matrix: We added the Custom Constraint and the Constraint Matrix, which allow us to build customized constraints related to Lower Snake River (LSR) transmission, Mid-Columbia (Mid-C) transmission, and generation limits for resources delivering at Mid-C.

Fuels: The fuels table provides information for fuel types and default resource assumptions. We added new fuels types in this table for fuels with an RFP suffix to distinguish RFP fuels from generic new resource fuels. We also added a TriHybrid Fuel ID to use as fuel source for the renewable portion of a generic Solar + Wind + Battery generic resource option.

New Resources: This table contains the input assumptions and operating parameters for new resource options that are evaluated during a Long-Term Capacity Expansion study. Appendix D: Generic Resource Alternatives of the 2023 Electric Progress Report describes new resource alternatives in detail.

For this analysis, we made a number of updates to the New Resources table including:

New generic resources

- Move the First Eligible Year from 2024 to 2029 so RFP offers do not compete with generic resource options when meeting the energy, clean energy targets established by the Clean Energy Transformation Act (CETA), and peak capacity need in the timeframe RFP offers are available
- Update the Annual Max based on the maximum per year added for the 23 EPR Preferred/Reference portfolios. Setting the value to a lower limit impacts the run time when performing a Long-Term Capacity Expansion Study
- Update the Overall Max based on the adjusted tranches for generic new resources after taking into account the nameplate capacity of RFP offers selected in a prior Aurora run.
- Disabled *Pump Hydro Energy Storage, Demand Response, and Balanced Resources* options; equivalent options are available through the RFP offers
- Triple Hybrid Resources: combine the renewable portion (solar and wind) of the triple hybrid option since Aurora does not allow for mutltiple new resource id prefaced by "nr_id_" as a charging resource in the Long-Term Capacity Expansion study

Power Bridging Agreements

- Add two types of Power Bridging Agreement options; one type is able to contribute to the peak, the other type is eligible to meet CETA targets. These are short-term contracts available to fill the peak and CETA need in years 2024 and 2025 when few RFP offers are available.

RFP Offers

- The RFP team pre-screened offers obtained via the 2021 RFP and bi-lateral channels. Those offers are included in the New Resources table as options for the model to evaluate and select to meet the energy, clean energy and peak capacity requirements.

Portfolio Resources: The portfolio analysis uses this table to determine what resources are included in the PSE portfolio. We added the generic new triple hybrid resource, power bridging agreement options and the RFP offers to this table.

Resource Groups: The resource group table provides the ability to define or designate a number of resources into one group. We added new resource groups associated with the RFP offers in order to implement constraints related to the mutual exclusivity of certain RFP offers.

Time Series Annual, Monthly, Hourly, and Generic: These tables contain the time series references or variable values that change annually, monthly or an hourly basis. We added the data related to the RFP offers to these tables including capacity, costs, reliable capacity, and shapes.

Time Series Pattern: We added the Time Series Pattern table to define custom time slices required to model the commercial delivery date of RFP offers that do not start at the beginning of the year.

The updated 2021 RFP Input File contains the new data inputs used in the analysis incremental to Appendix H: Electric Analysis and Portfolio Model of the 2023 EPR and will be available at the completion of the analysis.

2.4. Other Updates

2.4.1. ELCC Tranches

By design, the model only evaluates and selects RFP resources between 2024 and 2028 with Power Bridging agreements available in 2024 and 2025. Starting in 2029, new generic resource options are available to meet the energy, peak, and clean energy requirements in the Long-Term Capacity Expansion study. There are 3 ELCC tranches modeled for the generic new resource options in the 2023 Electric Progress Report. For discussion on the saturation effects on resource ELCCs, see Chapter Seven: Resource Adequacy Analysis of the 2023 Electric Progress Report.

To take into account the ELCC saturation effects for the selection of the RFP offers, we adjusted the availability of generic resource options within the resource category tranche limit. We used an iterative approach to estimate the capacity of selected RFP offers to displace generic resources in the ELCC tranches. As an example, preliminary results show that approximately 1,500 MW of storage RFP offers are selected before any generic new storage options become available. The cumulative nameplate limit for tranche 1 and 2 for storage resources is 1,500 MW. This means that the RFP offers selected already saturated tranche 1 and 2, and any additional generic new storage options will come in at tranche 3, which has a lower ELCC. We updated the constraints table in Aurora to reflect the adjusted available capacity for the tranches and the resource categories. Table 1.3 below illustrates the updated MW limit used in Aurora for this analysis.

Table 1.3 Modeling ELCC Tranches Limits for Generic New Resources

Summary (MW)	23 EPR ELCC Tranches			Estimated RFP Offer Selection (as of 5/31/23)			Updated Constraints for Modeling Tranche Limits		
Category	1	2	3	1	2	3	1	2	3
Solar	100	400	2,500	100	300	-	-	100	2,500
Northwest Wind	100	900	2,000	100	700	-	-	200	2,000
Rockies Wind	100	900	1,000	100	900	100	-	-	900
Hybrid	1,000	500	3,500	200	-	-	800	500	3,500
Storage	1,000	500	3,500	1,000	500	200	-	-	3,300

3. QA / QC Process

As with most software, the quality of data inputs provided to Aurora is a major contributor to the quality of results obtained from the Aurora simulations. With the inclusion of RFP resources for long-term resource selection in addition to the available generic resources in the EPR database and the change in the version of Aurora used for the simulations, we adopted several steps to check for data quality and obtain a robust output solution.

We ran simulations to benchmark the 2023 EPR database outputs between Aurora 14.1.1036, which used for the Preferred Portfolio model, and Aurora 14.2.1059, which is used for this analysis. As listed in Table 1.1, the portfolio cost difference between the two models was about 0.2% and there were some differences in the resources selected by the long term capacity expansion runs in the two versions. With mathematical tools such as Aurora, a certain amount of deviation between runs is possible since the optimization is run with a tolerance threshold for solution convergence and is also dependent on other factors such as the machine used and tasks running on that machine.

The RFP team provided multiple iterations of data updates. We ran several test simulations after each iterative round of updates to check the quality of outputs obtained and determine whether any warnings were reported for the simulations. These checks include:

- Validating the capacity, fixed and variable costs, resource output shapes, reliable capacity contributions of the RFP resources on the output side to ensure input updates flow through correctly
- Operational constraints such as transmission limits or generation limits modeled for the resources were checked in the simulation output for violations. Some other examples are resource mutual exclusivities and dependencies
- The Aurora study log obtained as part of the output of a simulation run lists errors and warnings encountered by the solver during the run. These errors and warnings in the test simulations were examined for data and user errors based on which additional updates were incorporated into the model

A significant amount of post simulation analysis is performed in this analysis. We incorporated constraint checks for the planning reserve margin requirement and CETA need in the output post-processing step, to help ascertain whether there is a deficit in a given year or whether the constraint violations are indicative of modeling issues.

4. Reference and Portfolio Sensitivity Results

The Run1 reference portfolio is the most similar in terms of modeling assumptions as 2023 EPR preferred portfolio. With the replacement of new generic resource options for resource selection in the near-term with RFP offers and power bridging agreement options, the Run1 reference portfolio still meets CETA, energy, and reliability requirements in the analysis. The Run1 reference portfolio cost is $19.2 billion (NPV 2024 – 2025), and the social cost of greenhouse gases (SCGHG) is $3.0 billion, totaling $22.2 billion in total portfolio costs. The Run1 reference portfolio sets the stage as the starting point for sensitivity risk analysis that helps us understand how specific assumptions change the mix of resources in the portfolio and affect portfolio costs. Examples of a sensitivity include delaying the start date of an RFP resource, increasing the nameplate limit for Montana RFP resources, or excluding a specific RFP resource in the new resource selection. Some major themes that we observed in the analysis include the following:

- Resources are added to meet capacity need.
- The renewable resources exceed the CETA target because there are limited options to meet the capacity need.
- Over 1,300 MW nameplate of energy storage added by 2028, greater than the energy storage added in the 2023 Electric Progress Report Preferred Portfolio.

4.1. Summary Tables and Figures

This section provides summarized results of portfolio costs, resource selection, effective winter capacity and CETA eligible energy for each portfolio.

Table 1.4 Portfolio Costs, 2024–2045 NPV (Billions)

Sensitivity Costs in Billions $ NPV 2024 - 2045	Portfolio Cost ($Billions)	SCGHG Costs ($Billions)	Total ($Billions)	Change from Reference ($Billions)	Change from Reference (%)
Run1 - Reference	19.18	3.00	22.18	0.00	-
Run2	20.18	3.18	23.36	1.19	5%
Run3	20.81	3.22	24.03	1.86	8%
Run4	19.11	2.78	21.89	-0.28	-1%
Run5	19.29	2.81	22.09	-0.08	0%
Run6	20.15	3.15	23.30	1.13	5%

Figure 1.1 Resources selected by Portfolio

Type	Name	Run1	Run2	Run3	Run4	Run5	Run6
BESS	[redacted]	Y	Y	Y	Y	Y	Y
BESS		Y	Y	Y	Y	Y	Y
BESS		Y	Y	Y	Y	Y	Y
BESS		Y	Y	Y	Y	Y	Y
BESS		Y		Y	Y		Y
BESS		Y			Y		Y
BESS		Y	Y	Y	Y	Y	Y
BESS		Y	Y	Y	Y	Y	Y
BESS			Y	Y		Y	
BESS		Y	Y	Y	Y	Y	Y
Solar		Y				Y	
Solar		Y	Y				Y
Solar			Y	Y		Y	
Solar		Y	Y	Y	Y	Y	Y
Solar		Y	Y	Y	Y	Y	Y
Solar					Y	Y	
Solar		Y	Y	Y		Y	Y
Wind		Y	Y		Y	Y	Y
Wind	Vantage Wind	Y	Y	Y	Y	Y	Y
Wind	[redacted]						
Wind	*Beaver Creek Wind*	Y		Y	Y	Y	Y
Wind		Y	Y	Y	Y	Y	Y
Wind		Y	Y	Y	Y	Y	Y
Wind		Y	Y	Y	Y	Y	Y
Wind					Y	Y	
Biodiesel		Y	Y	Y	Y	Y	Y
Hybrid/Solar		Y	Y	Y	Y		
Hybrid/Solar		Y	Y	Y	Y		
Hybrid/Solar			Y	Y			Y
Hybrid/Solar			Y	Y			Y
Hybrid/Solar		Y					
Hybrid/Solar		Y					
Hydro		Y	Y	Y	Y	Y	Y
PSH						Y	

Figure 1.2 Effective Winter Peak Capacity by Resource Type by 2028

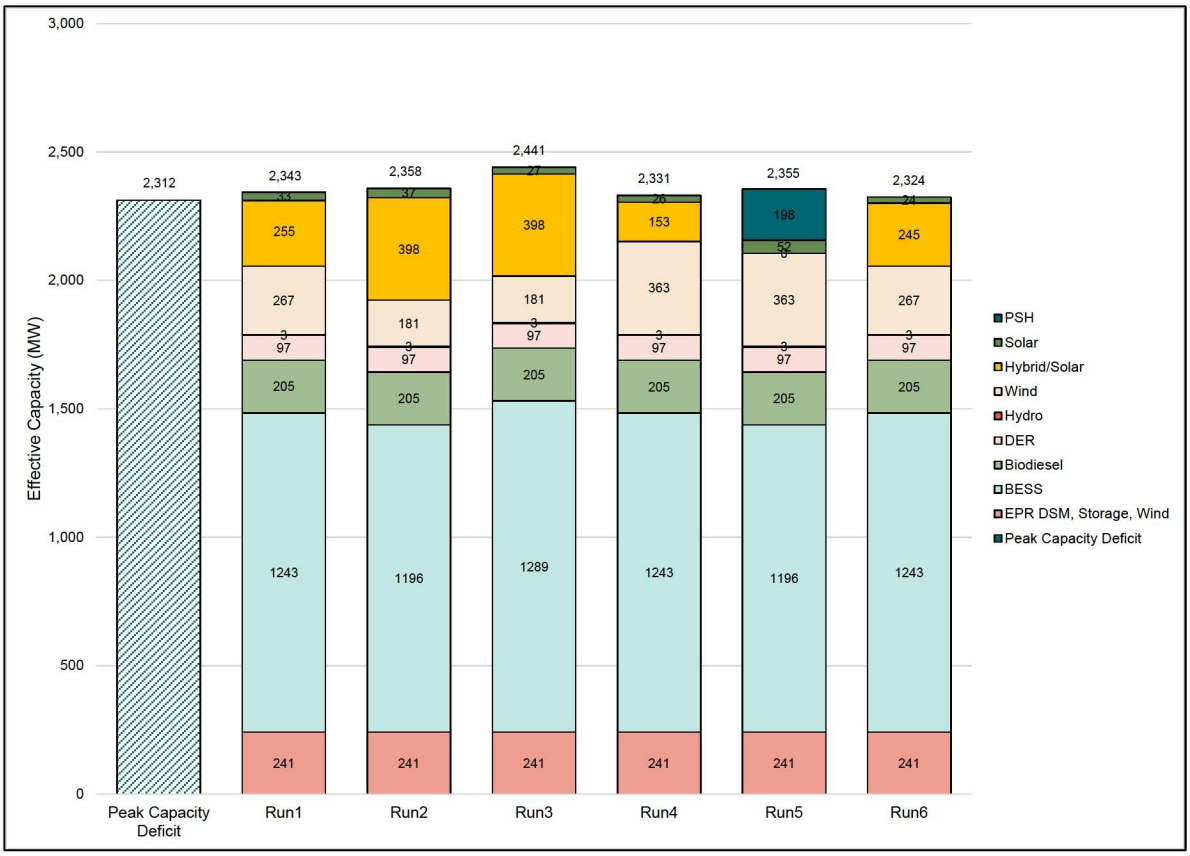
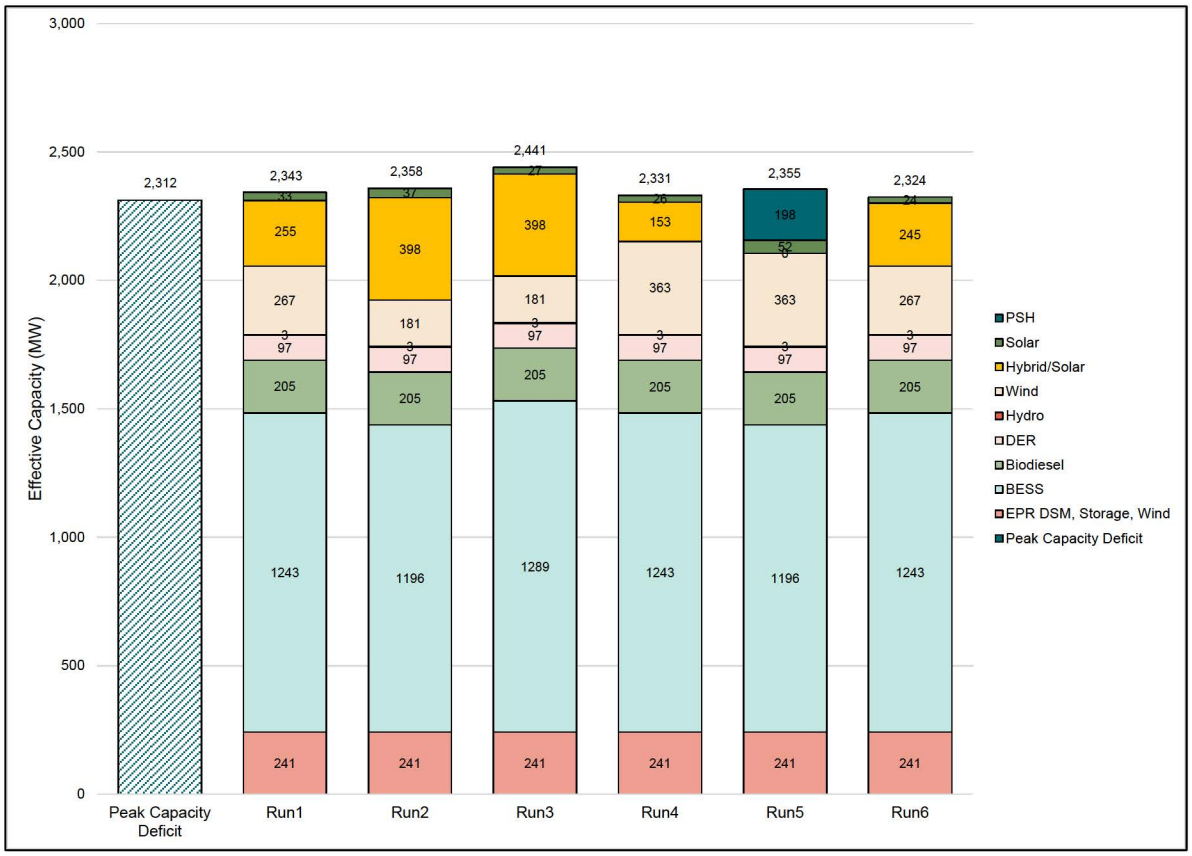


Figure 1.3 CETA Qualifying Energy Resource Type for 2028



4.2. A closer look at Beaver Creek Wind

In addition to the Quantitative analysis for the RFP decision making process, several other factors are also considered for resource selection. With limited resources being available in the near future, Beaver Creek stands out as a resource option with a comparatively advanced timeline. Although, the resource seems favorable in terms of availability, we performed due diligence to check whether the optimization model selects Beaver Creek based on the information we have at the time of running the simulations. We examined the portfolios modeled for this analysis and observed that the Beaver Creek was selected in the new resource selection for 5 of the portfolios except for Run2, where we excluded Beaver Creek as an option to test the value to the portfolio. In Run2 the total portfolio costs increased by $1 billion over the reference portfolio. We also tested delay risk in the start date of Beaver Creek, Run6, where the commercial online date was moved to 2026 instead of 2025. In this run, Beaver Creek was still selected as part of the least cost solution.

Table 1.5 Beaver Creek selection by Portfolio

Sensitivity	Beaver Selected As Least Cost Solution?
Run1 - Reference	Yes
Run2	No (Forced Out)

MODELING UPDATES FOR ANALYSIS INCLUDING BEAVER CREEK

Sensitivity	Beaver Selected As Least Cost Solution?
Run3	Yes
Run4	Yes
Run5	Yes
Run6	Yes

After the Analysis was complete, we received an update on pricing. This added [redacted] MWh levelized to the cost of Beaver Creek which comes to an additional [redacted] million NPV 2024 – 2045 and has minimal impact to the total portfolio cost of $19.1 billion.

REDACTED VERSION

SHADED INFORMATION IS DESIGNATED AS CONFIDENTIAL PER WAC 480-07-160

PUGET SOUND ENERGY

2021 RFP: Post-Phase 2 Update

Attachment B. Updated Optimization Analysis

November 2023

2021 ALL–SOURCE REQUEST FOR PROPOSAL

MODELING UPDATES November 2023

PUGET SOUND ENERGY

Contents

1. Introduction and Key Assumptions

The objective of this document is to describe the modeling assumptions, methods and results used to support modeling for the 2021 All-Source Request for Proposal (2021 RFP). This document summarizes the analysis performed, beginning in April 2023, when the resource planning team transitioned into the role of performing portfolio analytics. Modeling related to the 2021 RFP and resource acquisitions prior to this period is not addressed in this document. The modeling framework described herein builds upon previous analytical work completed for the 2021 RFP and 2023 Electric Progress Report (2023 EPR).

PSE filed the 2023 Electric Progress Report with the Washington Utilities and Transportation Commission on March 31, 2023. The 2023 EPR provides a two-year progress report on the 2021 IRP as required by Clean Energy Transformation Act (CETA). The assumptions and documentation of the 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. The 2023 EPR Preferred Portfolio serves as a starting point for the 2021 RFP Analysis. In addition, new contracts incorporated in PSE's 2023 Biennial CEIP Update filed on November 1, 2023 to help achieve 80% clean or non-emitting energy by 2030 and 100% by 2045 are also incorporated in this analysis.

For the purposes of this RFP analysis, we created a reference portfolio and then tested sensitivities from the reference. At a high level, the analysis began with using the Aurora portfolio model to identify the least-cost set of resource alternatives from the list of resources under consideration. The initial reference case was then used as the starting point for a series of sensitivities, to estimate the portfolio benefit of several, potential high-priority resource alternatives. The portfolio benefits were estimated by removing each such resource as a resource alternative, then running Aurora without that alternative. This approach provides data to estimate the value of each individual resource over a variety of time horizons, to better understand how valuable each individual resource would be to the portfolio. This is important for a variety of reasons, including understanding if resources have significant value relative to each other, or if they are very close in portfolio value. Additionally, this approach identifies the next-best alternative, should the specific resource being studied end up not being available. The same approach was used on some resources that did not appear in the Aurora-generated reference portfolio, to understand how far out of the money a resource might be, as some resources might not have been included in the reference case, but were within rounding error. The portfolios tested in the analysis are:

- Scenario 1: Reference case
- Scenario 2: Reference case without Power Bridging Agreements (PBA)
- Sensitivity 1: Reference + Beaver Creek wind Not Available (N/A) as an alternative
- Sensitivity 2: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 3: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 4: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 5: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 6: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 7: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 8: Reference + [redacted] ot Available (N/A) as an alternative

- Sensitivity 9: Reference + all [redacted] Not Available (N/A) as an alternative
- Sensitivity 10: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 11: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 12: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 13: Reference + [redacted] as a must-take resource
- Sensitivity 14: Reference + [redacted] as a must-take resource
- Sensitivity 15: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 16: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 17: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 18: Reference + Beaver Creek BESS Not Available (N/A) as an alternative
- Sensitivity 19: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 20: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 21: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 22: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 23: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 24: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 25: Reference + [redacted] Not Available (N/A) as an alternative
- Sensitivity 26: Reference + [redacted] Not Available (N/A) as an alternative, move COD for offer 3 to 2027

2. Updates to the 2023 EPR Preferred Portfolio Aurora Model

As part of this analysis, we made several updates to the 2023 EPR Preferred Portfolio Aurora Model in order to evaluate new resource offers received through the 2021 RFP and bi-lateral channels. This section describes the changes to the Aurora Model.

2.1. Aurora Version

The 2023 EPR utilized Energy Exemplar's Aurora Model version 14.1.1036 in developing the Preferred Portfolio. Since then, Energy Exemplar released Aurora version 14.2.1059 which we adopted for this analysis. Some of the benefits of Aurora version 14.2.1059 include improvements to energy storage modeling and reduction to the run time of the study. Benchmarking tests on the 2023 EPR Reference Portfolio between the two Aurora versions reflect a decrease in portfolio costs and minor changes in overall builds including a slight shift to slightly more solar + battery hybrid, while significantly improving model run time.

Table 1.1 Benchmarking 2023 EPR Reference Portfolio Costs, 2024–2045 NPV ($ Billions)

2023 EPR Reference Portfolio	Portfolio Cost ($)	SCGHG Costs ($)	Total ($)	Change from v14.1 ($)	Change from v14.1 (%)
Aurora version 14.1.1036	17.61	3.24	20.85	0.00	-

2023 EPR Reference Portfolio	Portfolio Cost ($)	SCGHG Costs ($)	Total ($)	Change from v14.1 ($)	Change from v14.1 (%)
Aurora version 14.2.1059	17.66	3.18	20.84	-0.01	0.00

2.2. Project Setup

Several updates were made to the Aurora project settings in order to be consistent with the setup from earlier analyses including:

- Move the study period End Date to finish in 2045 instead of 2047
- Adjust the dispatch week sampling schedule of the LTCE simulation to sample the 1st and 3rd weeks of the month instead of the 2nd week of the month
- Uncheck the Remove Penalty Adders from Pricing to limit the influence of penalties on the simulation solution
- Check the Use Capacity Price Table as an input with zero as the capacity value for resources to limit the influence of AURORA's capacity price calculation on simulation solution
- Change the parallel processing setup to use maximum parallel solves of 5 and parallelized across 4 years to improve run time and maintain simulation consistency

2.3. Input Tables

This section briefly summarizes the changes made to the Aurora Input tables for this analysis.

Constraint: The constraint table reflects the long-term capacity maximum values for generic new resources used to limit the nameplate additions by resource categories. This table works in conjunction with the generic resource records in the New Resources table. We updated the capacity limits (megawatts; MW) for generic new resources in this analysis to account for the selection of RFP offers prior to the selection of generic new resources. More information on the generic new resources Effective Load Carrying Capability (ELCC) tranche adjustments is available section 2.4.1 ELCC Tranches.

Custom Constraint and Constraint Matrix: We added the Custom Constraint and the Constraint Matrix, which allow us to build customized constraints related to Lower Snake River (LSR) transmission, Mid-Columbia (Mid-C) transmission, and generation limits for resources delivering at Mid-C.

Fuels: The fuels table provides information for fuel types and default resource assumptions. We added new fuels types in this table for fuels with an RFP suffix to distinguish RFP fuels from generic new resource fuels. We also added a TriHybrid Fuel ID to use as fuel source for the renewable portion of a generic Solar + Wind + Battery generic resource option.

New Resources: This table contains the input assumptions and operating parameters for new resource options that are evaluated during a Long-Term Capacity Expansion study. Appendix D: Generic Resource Alternatives of the 2023 Electric Progress Report describes new resource alternatives in detail.

For this analysis, we made a number of updates to the New Resources table including:

New generic resources

- Move the First Eligible Year from 2024 to 2031 so RFP offers do not compete with generic resource options when meeting the energy, clean energy targets established by the Clean Energy Transformation Act (CETA), and peak capacity need in the timeframe RFP offers are available
- Update the Annual Max based on the maximum per year added for the 23 EPR Preferred/Reference portfolios. Setting the value to a lower limit impacts the Sensitivity time when performing a Long-Term Capacity Expansion Study
- Update the Overall Max based on the adjusted tranches for generic new resources after taking into account the nameplate capacity of RFP offers selected in a prior Aurora simulation.
- Disabled *Pump Hydro Energy Storage, Demand Response, and Balanced Resources* options; equivalent options are available through the RFP offers
- Triple Hybrid Resources: combine the renewable portion (solar and wind) of the triple hybrid option since Aurora does not allow for mutltiple new resource id prefaced by "nr_id_" as a charging resource in the Long-Term Capacity Expansion study

Power Bridging Agreements

- Two types of Power Bridging (PBA) agreements were utilized in the modeling process. One type of PBA is able to contribute to the peak, the other type is eligible to meet CETA targets. These are short-term contracts available to fill the peak and CETA need for years 2024 through 2030 when few RFP offers are available. The two kinds of PBAs were used to understand whether Aurora might be identifying an unreasonably high cost, long-term resource alternative, simply because nothing else was available to the model to meet the specified constraints. The variable price for the PBA is consistent with the total market price from the 2023 EPR which is the sum of the wholesale market price + social cost of greenhouse as adder + CCA adder. Capacity related PBA prices were estimated based on the levelized avoided costs of capacity for a biodiesel peaker summmarized in Appendix I: Output Levelized Resource Costs of the the 2023 EPR. PBAs were modeled one-year contracts 10 for CETA and 10 for capacity of 100 MW available in any year between 2024 and 2030.

RFP Offers

- The RFP team pre-screened offers obtained via the 2021 RFP and bi-lateral channels. Those offers are included in the New Resources table as options for the model to evaluate and select to meet the energy, clean energy and peak capacity requirements.

Portfolio Resources: The portfolio analysis uses this table to determine what resources are included in the PSE portfolio. We added the generic new triple hybrid resource, power bridging agreement options and the RFP offers to this table.

Resources: The resources table contains input assumptions and parameters for all existing resources in the database. New contracts signed after the 2023 EPR was finished and included in the 2023 CEIP Biennial Update were also added to this table. Appendix A-1: Aurora Modeling Analysis of the 2023 CEIP Biennial Update describes the new

supply-side resources, demand response programs, and distributed solar and storage resources added to the Aurora database.

Resource Groups: The resource group table provides the ability to define or designate a number of resources into one group. We added new resource groups associated with the RFP offers in order to implement constraints related to the mutual exclusivity of certain RFP offers.

Time Series Annual, Monthly, Hourly, and Generic: These tables contain the time series references or variable values that change annually, monthly or an hourly basis. We added the data related to the RFP offers to these tables including capacity, costs, reliable capacity, and shapes.

Time Series Pattern: We added the Time Series Pattern table to define custom time slices required to model the commercial delivery date of RFP offers that do not start at the beginning of the year.

2.4. Other Updates

2.4.1. ELCC Tranches

By design, the model only evaluates and selects RFP resources between 2024 and 2030 with Power Bridging agreements available between 2024 and 2030. Starting in 2031, new generic resource options are available to meet the energy, peak, and clean energy requirements in the Long-Term Capacity Expansion study. There are 3 ELCC tranches modeled for the generic new resource options in the 2023 Electric Progress Report. For discussion on the saturation effects on resource ELCCs, see Chapter Seven: Resource Adequacy Analysis of the 2023 Electric Progress Report.

To take into account the ELCC saturation effects for the selection of the RFP offers, we adjusted the availability of generic resource options within the resource category tranche limit. We used an iterative approach to estimate the capacity of selected RFP offers to displace generic resources in the ELCC tranches. As an example, preliminary results show that approximately 1,500 MW of storage RFP offers are selected before any generic new storage options become available. The cumulative nameplate limit for tranche 1 and 2 for storage resources is 1,500 MW. This means that the RFP offers selected already saturated tranche 1 and 2, and any additional generic new storage options will come in at tranche 3, which has a lower ELCC. We updated the constraints table in Aurora to reflect the adjusted available capacity for the tranches and the resource categories. Table 1.2 below illustrates the updated MW limit used in Aurora for this analysis.

Table 1.2 Modeling ELCC Tranches Limits for Generic New Resources

Summary (MW)	23 EPR ELCC Tranches			Estimated RFP Offer Selection (as of 5/31/23)			Updated Constraints for Modeling Tranche Limits		
Category	1	2	3	1	2	3	1	2	3
Solar	100	400	2,500	100	300	-	-	100	2,500
Northwest Wind	100	900	2,000	100	700	-	-	200	2,000
Rockies Wind	100	900	1,000	100	900	100	-	-	900

Summary (MW)	23 EPR ELCC Tranches			Estimated RFP Offer Selection (as of 5/31/23)			Updated Constraints for Modeling Tranche Limits		
Hybrid	1,000	500	3,500	200	-	-	800	500	3,500
Storage	1,000	500	3,500	1,000	500	200	-	-	3,300

2.4.2. Build Limit for Montana Resources

We performed additional analysis examining a higher build limit from 950 MW to 1,200 MW for existing and new Montana renewable resources (wind and solar) resources. The new resources offered to PSE at the time of this analysis are shown in Table 1.3 below. This includes 200 MW of 4-hour battery, and 1607 MW of renewable resources. There are a total of 768 possible combinations for the Montana resources.

Table 1.3 Available RFP Offers from the Montana Region

Aurora ID Final	Mutual Exclusivity	Project	Resource type	Location	COD/Term start	Nameplate (MW)
5684_3		[redacted]	Battery (4 hr)	[redacted] MT	12/1/2025	[redacted]
8787_1			Battery (4 hr)	[redacted] MT	8/15/2025	
5684_1			Solar	[redacted] MT	12/1/2026	
8784_1			Solar	[redacted] MT	6/30/2026	
1413_2a	1413_1, 1413_2 (must be taken with 1413_2(b))		Wind	[redacted] MT	12/31/2027	
1413_2b	1413_1, 1413_2 (must be taken with 1413_2(a))		Wind	[redacted] MT	12/31/2028	
1413_1	1413_1, 1413_2		Wind	[redacted] MT	12/31/2027	
8785_1			Wind	[redacted] MT	6/30/2026	
8781_1		Beaver Creek Wind	Wind	Stillwater, MT	8/15/2025	232

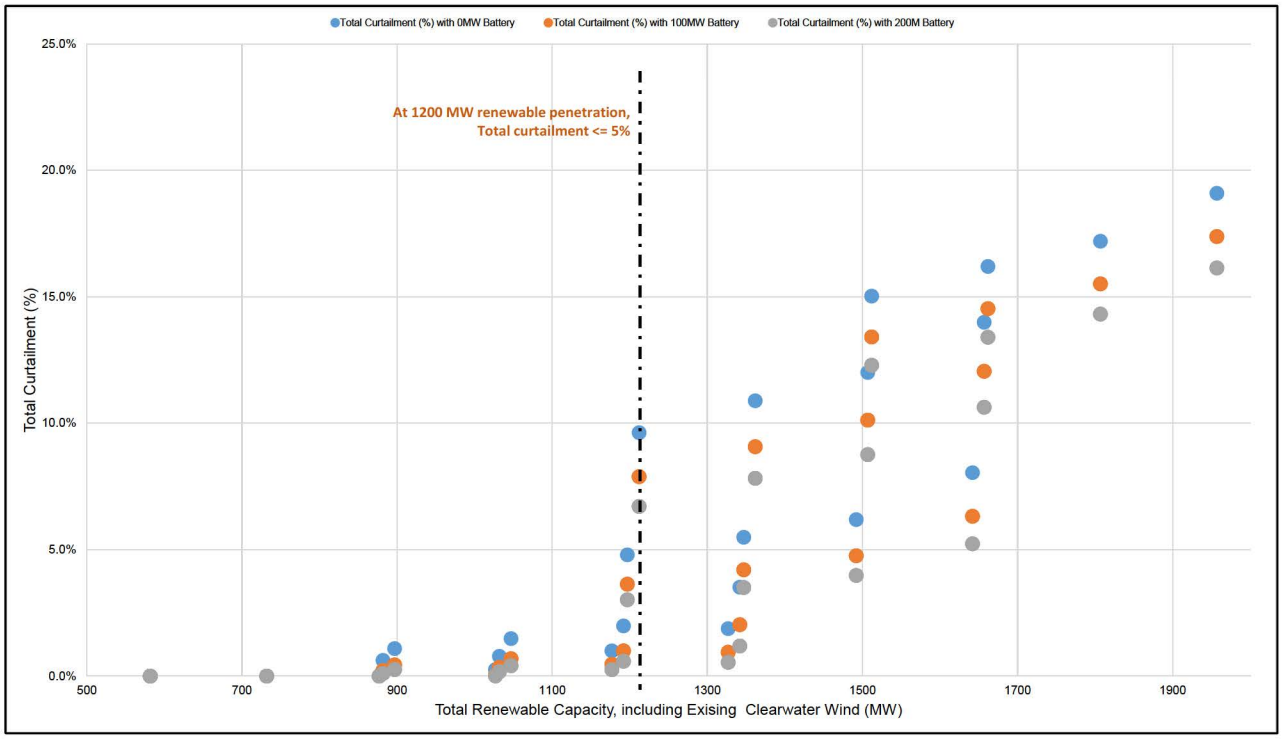
With the retirement of Colstrip coal plant, a total of 713 MW transmission capacity from Montana to PSE area will be available to serve both existing and new resources from 2026.

The analysis starts with a combination of resources in the table.

- For each hour in the year:
  - Dispatch each resource according to a price-taker model. Dispatch includes charge and discharge of batteries if included in the resource combination.
  - Compare the total generation dispatch with the 713 MW transmission limit.
  - If the total dispatch is greater than 713 MW then curtail renewable output such that total generation equal to 713 MW limit.
- Repeat above dispatch for all hours in the year.
- Total Curtailment (%) = Total Annual Curtailment / Total Annual Renewable Forecast X 100 (%)

The above calculation is repeated for each of 768 possible combinations. A relationship between Total Renewable Capacity and Total Curtailment (%) for each combination is shown in the following figure. Each dot represents a unique combination of resources in Figure 1.1 below. The Total Renewable Capacity includes both existing 350 MW Clearwater wind as well as new wind and solar in the table.

Figure 1.1 Curtailment Percent for Renewable Capacity combinations in Montana Region



The figure shows that total curtailment is less than 5% at *(i)* any battery integration level and *(ii)* any renewable capacity level up to 1,200 MW. While there is no standard defining an acceptable curtailment level, 5% is considered reasonable and the renewable capacity of 1,200 MW associated with this curtailment level is recommended as the upper limit for downstream Aurora capacity expansion model. From some of our initial test runs we observed that the 1,200 MW limit seemed to have the impact of preventing certain resource combinations from being selected as the

constraint limit would be violated by about 20 MW. We baked in a buffer of 5% to change the constraint limit to 1,260 MW in the Aurora model to prevent this.

3. QA / QC Process

As with most software, the quality of data inputs provided to Aurora is a major contributor to the quality of results obtained from the Aurora simulations. With the inclusion of RFP resources for long-term resource selection in addition to the available generic resources in the EPR database and the change in the version of Aurora used for the simulations, we adopted several steps to check for data quality and obtain a robust output solution.

We ran simulations to benchmark the 2023 EPR database outputs between Aurora 14.1.1036, which used for the Preferred Portfolio model, and Aurora 14.2.1059, which is used for this analysis. As listed in Table 1.1, the portfolio cost difference between the two models was about 0.2% and there were some differences in the resources selected by the long term capacity expansion runs in the two versions. With mathematical tools such as Aurora, a certain amount of deviation between runs is possible since the optimization is run with a tolerance threshold for solution convergence and is also dependent on other factors such as the machine used and tasks running on that machine.

The RFP team provided multiple iterations of data updates. We ran several test simulations after each iterative round of updates to check the quality of outputs obtained and determine whether any warnings were reported for the simulations. These checks include:

- Validating the capacity, fixed and variable costs, resource output shapes, reliable capacity contributions of the RFP resources on the output side to ensure input updates flow through correctly
- Operational constraints such as transmission limits or generation limits modeled for the resources were checked in the simulation output for violations. Some other examples are resource mutual exclusivities and dependencies
- The Aurora study log obtained as part of the output of a simulation lists errors and warnings encountered by the solver during the run. These errors and warnings in the test simulations were examined for data and user errors based on which additional updates were incorporated into the model

A significant amount of post simulation analysis is performed in this analysis. We incorporated constraint checks for the planning reserve margin requirement and CETA need in the output post-processing step, to help ascertain whether there is a deficit in a given year or whether the constraint violations are indicative of modeling issues.

4. Reference and Portfolio Sensitivity Results

4.1. Reference portfolio

The reference portfolio is the most similar in terms of modeling assumptions as 2023 EPR preferred portfolio. With the replacement of new generic resource options for resource selection in the near-term with RFP offers and power bridging agreement options, the reference portfolio still meets CETA in 2030, energy, and reliability requirements in

the analysis. The reference portfolio cost is $20.39 billion (NPV 2024 – 2045), and the social cost of greenhouse gases (SCGHG) is $2.94 billion, totaling $23.34 billion in total portfolio costs. Some major themes that we observed in the analysis include the following:

- Resources are added to meet winter capacity need.
- Over 1,400 MW nameplate of energy storage added by 2028, greater than the energy storage added in the 2023 Electric Progress Report Preferred Portfolio.

4.2. Reference without Power Bridging Agreement

Without the proxy Power Bridging Agreement, the model selects more RFP offers than what was in the reference portfolio to help meet the CETA target in 2030 and peak capacity needs in the near-term. The portfolio cost for the reference portfolio without Power Bridging Agreement is $21.86 billion (NPV 2024 – 2045), and the social cost of greenhouse gases (SCGHG) is $2.91 billion, totaling $24.77 billion in total portfolio costs. Some major themes that we observed in the analysis include the following:

- Slightly more RFP hybrid resources are added to the portfolio. The BESS component of the hybrid resources are necessary to meet the peak capacity from 2025 through 2029.
- Without Power Bridging Agreements, this portfolio is short of meeting the peak capacity need in the 2030. While the [redacted] RFP offer is available in 2030 for resource selection, its COD date of 12/31/2030 only provides one day of benefit for meeting the capacity needs in 2030.

4.3. Portfolio sensitivities

The reference portfolio sets the stage as the starting point for sensitivity risk analysis that helps us understand how specific assumptions change the mix of resources in the portfolio and affect portfolio costs. The focus of the sensitivities for this analysis is to estimate the benefit or costs of selecting individual RFP offers in the reference portfolio versus removing the same RFP offer as an option in the resource selection. For example, since Beaver Creek Wind is in the Reference portfolio, Sensitivity 1 is setup to turn off Beaver Creek Wind as an option in the resource selection. The Aurora model would then re-optimize and give us an insight as to the change in resource mix and portfolio costs when Beaver Creek Wind is unavailable.

4.4. Summary Tables and Figures

This section provides summarized results of portfolio costs, benefits and resource selection for each portfolio.

Table 1.4 Total Portfolio Costs, 2024–2045 NPV (Billions)

Scenario and Sensitivity	Portfolio Description	Portfolio Cost ($Billions)	SCGHG Costs ($Billions)	Total ($Billions)	Total Costs Increase/(Decrease) from Reference ($Billions)
Scenario_1	Reference	20.39	2.94	23.34	0.00
Scenario_2	Reference without PBA	21.86	2.91	24.77	1.43
Sensitivity_1	Beaver Creek Wind N/A	21.28	3.07	24.35	1.01
Sensitivity_2	[redacted]	20.46	3.26	23.73	0.39
Sensitivity_3		20.28	3.16	23.44	0.10
Sensitivity_4		20.40	3.24	23.64	0.30
Sensitivity_5		20.81	3.15	23.96	0.63
Sensitivity_6		21.10	2.97	24.07	0.74
Sensitivity_7		21.25	3.00	24.25	0.91
Sensitivity_8		20.37	3.09	23.46	0.12
Sensitivity_9		20.98	2.97	23.95	0.61
Sensitivity_10		20.40	3.23	23.62	0.29
Sensitivity_11		20.65	3.05	23.71	0.37
Sensitivity_12		20.21	3.34	23.55	0.21
Sensitivity_13		20.33	3.26	23.59	0.25
Sensitivity_14		20.23	3.03	23.26	(0.08)
Sensitivity_15		20.47	3.18	23.66	0.32
Sensitivity_16		20.90	3.26	24.16	0.82
Sensitivity_17		20.74	2.87	23.61	0.27
Sensitivity_18	Beaver Creek Battery N/A	20.90	3.03	23.93	0.59
Sensitivity_19	[redacted]	20.03	3.24	23.27	(0.07)
Sensitivity_20		20.21	3.21	23.42	0.08
Sensitivity_21		20.17	3.27	23.44	0.10
Sensitivity_22		20.51	2.80	23.32	(0.02)
Sensitivity_23		20.48	2.97	23.45	0.12
Sensitivity_24		20.28	3.08	23.36	0.03
Sensitivity_25		20.20	3.08	23.29	(0.05)
Sensitivity_26		20.18	3.02	23.21	(0.13)

Table 1.5 Cost or Benefit based on 2024–2045 NPV (Billions)

Resource Type	Name	Reference	# Times selected (out of 28)	Total Portfolio Costs WITH RFP Offer ($Billions)	Total Portfolio Costs WITHOUT RFP Offer ($Billions)	Cost/(Benefit) ($Billions)	% Change
BESS	Beaver Creek Battery	Y	26	23.34	23.93	(0.59)	-2.53%
BESS	[redacted]	Y	27	23.34	23.66	(0.32)	-1.38%
BESS		Y	26	23.34	23.42	(0.08)	-0.33%
BESS		Y	27	23.34	23.44	(0.10)	-0.44%
BESS		Y	27	23.34	23.27	0.07	0.30%
BESS		Y	27	23.34	23.61	(0.27)	-1.15%
BESS		Y	27	23.34	24.07	(0.74)	-3.16%
BESS		Y	27	23.34	24.25	(0.91)	-3.91%
BESS		Y	24	23.34	23.96	(0.63)	-2.68%
BESS		Y	27	23.34	24.16	(0.82)	-3.52%
Solar		Y	27	23.34	23.64	(0.30)	-1.30%
Solar		Y	16	23.34	23.62	(0.29)	-1.23%
Solar		Y	19	23.34	23.71	(0.37)	-1.59%
Solar		N	6	23.26	23.34	(0.08)	-0.34%
Solar		N	6	23.59	23.34	0.25	1.05%
Wind	Beaver Creek Wind	Y	27	23.34	24.35	(1.01)	-4.34%
Wind	[redacted]	Y	24	23.34	23.73	(0.39)	-1.66%
Wind		Y	20	23.34	23.44	(0.10)	-0.45%
Wind		Y	27	23.34	23.55	(0.21)	-0.92%
Hybrid/BESS		Y	24	23.34	23.32	0.02	0.09%

Resource Type	Name	Reference	# Times selected (out of 28)	Total Portfolio Costs WITH RFP Offer ($Billions)	Total Portfolio Costs WITHOUT RFP Offer ($Billions)	Cost/(Benefit) ($Billions)	% Change
Hybrid/BESS	[redacted]	N	1	23.34	23.45	(0.12)	-0.50%
Hybrid/BESS		Y	23	23.34	23.29	0.05	0.21%
Hydro		Y	27	23.34	23.36	(0.03)	-0.11%
Biodiesel		Y	27	23.34	23.94	(0.60)	-2.58%

Figure 1.2 Resources selected by Portfolio: Reference, Reference without PBA and Sensitivities 1 - 3

Type	Name	Nameplate	COD	Reference Scenario_1	Reference without any PBA Scenario_2	Beaver Creek Wind N/A Sensitivity 1	Haymaker Wind 1 N/A Sensitivity 2	Clearwater Storage N/A Sensitivity 3
BESS	[redacted]		12/1/2026	Y	Y	Y	Y	
BESS			10/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2027	Y	Y	Y	Y	Y
BESS	**Beaver Creek Battery**	100	8/15/2025	Y	Y		Y	Y
BESS			12/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2026	Y			Y	Y
BESS			7/1/2026	Y	Y	Y	Y	Y
BESS			12/1/2025		Y	Y		
BESS			12/31/2025	Y	Y	Y	Y	Y
BESS			6/1/2026	Y	Y	Y	Y	Y
BESS			6/30/2026					
BESS			6/30/2026		Y	Y	Y	Y
BESS			12/31/2026	Y	Y	Y	Y	Y
Solar			6/30/2026			Y	Y	
Solar			12/31/2026		Y	Y		
Solar			6/30/2026	Y				Y
Solar			12/1/2026					
Solar			12/31/2025	Y	Y	Y	Y	Y
Solar			12/31/2026		Y			
Solar			12/31/2027		Y			
Solar			6/30/2026	Y			Y	Y
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y	Y	Y		Y
Wind			6/30/2026	Y	Y	Y	Y	Y
Wind			6/30/2028	Y	Y	Y	Y	
Wind	**Beaver Creek Wind**	248	3/31/2025	Y	Y		Y	Y
Wind			1/1/2027		Y	Y	Y	Y
Wind			12/31/2027		Y	Y		Y
Hybrid/BESS			12/31/2027	Y	Y	Y	Y	Y
Hybrid/BESS			6/30/2026		Y	Y		
Hybrid/BESS			12/1/2027	Y	Y	Y	Y	Y
Hybrid/BESS			6/1/2027					
Hybrid/Solar			12/31/2027	Y	Y	Y	Y	Y
Hybrid/Solar			12/1/2027	Y	Y	Y	Y	Y
Hybrid/Solar			6/1/2027					
Hybrid/Solar			6/30/2026		Y	Y		
Hydro			3/9/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2026					
Biodiesel			10/31/2026					

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Figure 1.3 Resources selected by Portfolio: Reference and Sensitivities 4 - 7

Type	Name	Nameplate	COD	Reference Scenario_1	Appaloosa Solar N/A Sensitivity 4	Spire Energy Storage N/A Sensitivity 5	Goldeneye N/A Sensitivity 6	Greenwater N/A Sensitivity 7
BESS	[redacted]		12/1/2026	Y	Y	Y	Y	Y
BESS			10/31/2026	Y	Y	Y		Y
BESS			12/1/2027	Y	Y	Y	Y	Y
BESS	**Beaver Creek Battery**	100	8/15/2025	Y	Y	Y	Y	Y
BESS			12/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2026	Y	Y		Y	Y
BESS			7/1/2026	Y	Y	Y	Y	Y
BESS			12/1/2025					
BESS			12/31/2025	Y	Y	Y	Y	
BESS			6/1/2026	Y	Y	Y	Y	Y
BESS			6/30/2026					Y
BESS			6/30/2026		Y		Y	
BESS			12/31/2026	Y	Y	Y	Y	Y
Solar			6/30/2026		Y			
Solar			12/31/2026			Y		
Solar			6/30/2026	Y	Y			
Solar			12/1/2026					
Solar			12/31/2025	Y		Y	Y	Y
Solar			12/31/2026					
Solar			12/31/2027					
Solar			6/30/2026	Y	Y			
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y		Y	Y	Y
Wind			6/30/2026	Y	Y	Y	Y	Y
Wind			6/30/2028	Y	Y		Y	Y
Wind	**Beaver Creek Wind**	248	3/31/2025	Y	Y	Y	Y	Y
Wind			1/1/2027			Y		
Wind			12/31/2027					
Hybrid/BESS			12/31/2027	Y	Y	Y		Y
Hybrid/BESS			6/30/2026			Y	Y	Y
Hybrid/BESS			12/1/2027	Y	Y	Y	Y	Y
Hybrid/BESS			6/1/2027					
Hybrid/Solar			12/31/2027	Y	Y	Y		Y
Hybrid/Solar			12/1/2027	Y	Y	Y	Y	Y
Hybrid/Solar			6/1/2027					
Hybrid/Solar			6/30/2026			Y	Y	Y
Hydro			3/9/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2026					
Biodiesel			10/31/2026					

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Figure 1.4 Resources selected by Portfolio: Reference and Sensitivities 8 - 11

Type	Name	Nameplate	COD	Reference Scenario_1	Seabrooke1 N/A Sensitivity 8	All Seabrooke N/A Sensitivity 9	HopHill220 MW N/A Sensitivity 10	HopHill 280MW N/A Sensitivity 11
BESS	[redacted]		12/1/2026	Y	Y	Y	Y	Y
BESS			10/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2027	Y	Y	Y	Y	Y
BESS	Beaver Creek Battery		8/15/2025	Y	Y	Y	Y	Y
BESS			12/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2026	Y	Y	Y	Y	Y
BESS			7/1/2026	Y	Y	Y	Y	Y
BESS			12/1/2025					
BESS			12/31/2025	Y	Y	Y	Y	Y
BESS			6/1/2026	Y	Y	Y	Y	Y
BESS			6/30/2026			Y		
BESS			6/30/2026		Y		Y	
BESS			12/31/2026	Y	Y	Y	Y	Y
Solar			6/30/2026				Y	
Solar			12/31/2026					
Solar			6/30/2026	Y	Y			
Solar			12/1/2026					
Solar			12/31/2025	Y	Y	Y	Y	Y
Solar			12/31/2026					
Solar			12/31/2027					
Solar			6/30/2026	Y	Y		Y	
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y	Y	Y		Y
Wind			6/30/2026	Y	Y	Y	Y	Y
Wind			6/30/2028	Y	Y	Y	Y	Y
Wind	Beaver Creek Wind	248	3/31/2025	Y	Y	Y	Y	Y
Wind			1/1/2027				Y	
Wind			12/31/2027			Y		
Hybrid/BESS			12/31/2027	Y	Y	Y	Y	
Hybrid/BESS			6/30/2026			Y		Y
Hybrid/BESS			12/1/2027	Y	Y	Y	Y	
Hybrid/BESS			6/1/2027					Y
Hybrid/Solar			12/31/2027	Y	Y	Y	Y	
Hybrid/Solar			12/1/2027	Y	Y	Y	Y	
Hybrid/Solar			6/1/2027					Y
Hybrid/Solar			6/30/2026			Y		Y
Hydro			3/9/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2025	Y			Y	Y
Biodiesel			10/31/2026		Y			
Biodiesel			10/31/2026					

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Figure 1.5 Resources selected by Portfolio: Reference and Sensitivities 12 - 15

Type	Name	Nameplate	COD	Reference Scenario_1	Silverthorn Wind N/A Sensitivity 12	Silverthorn Solar as must-take Sensitivity 13	RoyalSlope as must-take Sensitivity 14	BirchBay N/A Sensitivity 15
BESS	[redacted]		12/1/2026	Y	Y	Y	Y	Y
BESS			10/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2027	Y	Y	Y	Y	
BESS	**Beaver Creek Battery**	100	8/15/2025	Y	Y	Y	Y	Y
BESS			12/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2026	Y	Y	Y	Y	Y
BESS			7/1/2026	Y	Y	Y	Y	Y
BESS			12/1/2025					
BESS			12/31/2025	Y	Y	Y	Y	Y
BESS			6/1/2026	Y	Y	Y	Y	Y
BESS			6/30/2026					
BESS			6/30/2026		Y	Y		Y
BESS			12/31/2026	Y	Y	Y	Y	Y
Solar			6/30/2026		Y	Y		
Solar			12/31/2026		Y		Y	
Solar			6/30/2026	Y	Y		Y	Y
Solar			12/1/2026					
Solar			12/31/2025	Y	Y	Y	Y	Y
Solar			12/31/2026					
Solar			12/31/2027					
Solar			6/30/2026	Y	Y	Y	Y	Y
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y	Y		Y	Y
Wind			6/30/2026	Y		Y	Y	Y
Wind			6/30/2028	Y		Y	Y	
Wind	**Beaver Creek Wind**	248	3/31/2025	Y	Y	Y	Y	Y
Wind			1/1/2027		Y	Y		Y
Wind			12/31/2027					Y
Hybrid/BESS			12/31/2027	Y	Y	Y	Y	Y
Hybrid/BESS			6/30/2026					
Hybrid/BESS			12/1/2027	Y	Y	Y	Y	Y
Hybrid/BESS			6/1/2027					
Hybrid/Solar			12/31/2027	Y	Y	Y	Y	Y
Hybrid/Solar			12/1/2027	Y	Y	Y	Y	Y
Hybrid/Solar			6/1/2027					
Hybrid/Solar			6/30/2026					
Hydro			3/9/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2026					
Biodiesel			10/31/2026					

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Figure 1.6 Resources selected by Portfolio: Reference and Sensitivities 16 - 19

Type	Name	Nameplate	COD	Reference Scenario_1	StonyLake N/A Sensitivity 16	DoubleRN/A Sensitivity 17	BeaverCreek BESS N/A Sensitivity 18	CloverCreek N/A Sensitivity 19
BESS	[redacted]		12/1/2026	Y	Y	Y	Y	Y
BESS			10/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2027	Y	Y	Y	Y	Y
BESS	**Beaver Creek Battery**	100	8/15/2025	Y	Y	Y		Y
BESS			12/31/2026	Y		Y	Y	Y
BESS			12/1/2026	Y	Y	Y		Y
BESS			7/1/2026	Y	Y		Y	Y
BESS			12/1/2025				Y	
BESS			12/31/2025	Y	Y	Y	Y	Y
BESS			6/1/2026	Y	Y	Y	Y	
BESS			6/30/2026				Y	
BESS			6/30/2026			Y		Y
BESS			12/31/2026	Y	Y	Y	Y	Y
Solar			6/30/2026					
Solar			12/31/2026					
Solar			6/30/2026	Y		Y		Y
Solar			12/1/2026					
Solar			12/31/2025	Y	Y	Y	Y	Y
Solar			12/31/2026		Y	Y		
Solar			12/31/2027					
Solar			6/30/2026	Y		Y		Y
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y	Y	Y	Y	Y
Wind			6/30/2026	Y	Y	Y	Y	Y
Wind			6/30/2028	Y		Y	Y	
Wind	**Beaver Creek Wind**	248	3/31/2025	Y	Y	Y	Y	Y
Wind			1/1/2027		Y	Y		Y
Wind			12/31/2027			Y		Y
Hybrid/BESS			12/31/2027	Y	Y	Y	Y	Y
Hybrid/BESS			6/30/2026		Y		Y	
Hybrid/BESS			12/1/2027	Y	Y	Y		Y
Hybrid/BESS			6/1/2027					
Hybrid/Solar			12/31/2027	Y	Y	Y	Y	Y
Hybrid/Solar			12/1/2027	Y	Y	Y		Y
Hybrid/Solar			6/1/2027					
Hybrid/Solar			6/30/2026		Y		Y	
Hydro			3/9/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2026					
Biodiesel			10/31/2026					

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Figure 1.7 Resources selected by Portfolio: Reference and Sensitivities 20 - 23

Type	Name	Nameplate	COD	Reference Scenario_1	Christopher BESS N/A Sensitivity 20	LSR Wind N/A Sensitivity 21	CedarIsland N/A Sensitivity 22	DryFalls N/A Sensitivity 23
BESS	[redacted]		12/1/2026	Y	Y	Y	Y	Y
BESS			10/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2027	Y	Y	Y	Y	Y
BESS	**Beaver Creek Battery**	100	8/15/2025	Y	Y	Y	Y	Y
BESS			12/31/2026	Y	Y	Y	Y	Y
BESS			12/1/2026	Y	Y	Y	Y	Y
BESS			7/1/2026	Y	Y	Y	Y	Y
BESS			12/1/2025					
BESS			12/31/2025	Y	Y	Y	Y	Y
BESS			6/1/2026	Y	Y	Y	Y	Y
BESS			6/30/2026					
BESS			6/30/2026		Y	Y	Y	Y
BESS			12/31/2026	Y			Y	Y
Solar			6/30/2026					
Solar			12/31/2026				Y	
Solar			6/30/2026	Y	Y	Y	Y	Y
Solar			12/1/2026					
Solar			12/31/2025	Y	Y	Y	Y	Y
Solar			12/31/2026					
Solar			12/31/2027				Y	
Solar			6/30/2026	Y	Y	Y	Y	Y
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y	Y	Y	Y	Y
Wind			6/30/2026	Y	Y	Y	Y	Y
Wind			6/30/2028	Y			Y	Y
Wind	**Beaver Creek Wind**	248	3/31/2025	Y	Y	Y	Y	Y
Wind			1/1/2027		Y	Y	Y	
Wind			12/31/2027		Y	Y	Y	
Hybrid/BESS			12/31/2027	Y	Y	Y		Y
Hybrid/BESS			6/30/2026					
Hybrid/BESS			12/1/2027	Y	Y	Y	Y	
Hybrid/BESS			6/1/2027					
Hybrid/Solar			12/31/2027	Y	Y	Y		Y
Hybrid/Solar			12/1/2027	Y	Y	Y	Y	
Hybrid/Solar			6/1/2027					
Hybrid/Solar			6/30/2026					
Hydro			3/9/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2025	Y	Y	Y	Y	Y
Biodiesel			10/31/2026					
Biodiesel			10/31/2026					

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Figure 1.8 Resources selected by Portfolio: Reference and Sensitivities 24 - 26

Type	Name	Nameplate	COD	Reference Scenario_1	TwinFalls N/A Sensitivity 24	DryFalls Offer2 N/A Sensitivity 25	Seabrooke 1&2 N/A, Seabrooke 3 COD 2027 Sensitivity 26
BESS	[redacted]		12/1/2026	Y	Y	Y	Y
BESS			10/31/2026	Y	Y	Y	Y
BESS			12/1/2027	Y	Y	Y	Y
BESS	Beaver Creek Battery	100	8/15/2025	Y	Y	Y	Y
BESS			12/31/2026	Y	Y	Y	Y
BESS			12/1/2026	Y	Y	Y	Y
BESS			7/1/2026	Y	Y	Y	Y
BESS			12/1/2025				
BESS			12/31/2025	Y	Y	Y	Y
BESS			6/1/2026	Y	Y	Y	Y
BESS			6/30/2026				
BESS			6/30/2026			Y	Y
BESS			12/31/2026	Y	Y	Y	Y
Solar			6/30/2026				
Solar			12/31/2026				
Solar			6/30/2026	Y	Y	Y	Y
Solar			12/1/2026				
Solar			12/31/2025	Y	Y	Y	Y
Solar			12/31/2026				
Solar			12/31/2027				
Solar			6/30/2026	Y	Y	Y	Y
Wind	Vantage Wind	90	10/5/2025	Y	Y	Y	Y
Wind	[redacted]		12/31/2027	Y	Y	Y	Y
Wind			6/30/2026	Y	Y	Y	Y
Wind			6/30/2028	Y	Y	Y	Y
Wind	Beaver Creek Wind	248	3/31/2025	Y	Y	Y	Y
Wind			1/1/2027		Y		
Wind			12/31/2027				
Hybrid/BESS			12/31/2027	Y	Y	Y	Y
Hybrid/BESS			6/30/2026				
Hybrid/BESS			12/1/2027	Y	Y		Y
Hybrid/BESS			6/1/2027				
Hybrid/Solar			12/31/2027	Y	Y	Y	Y
Hybrid/Solar			12/1/2027	Y	Y		Y
Hybrid/Solar			6/1/2027				
Hybrid/Solar			6/30/2026				
Hydro			3/9/2025	Y		Y	Y
Biodiesel			10/31/2025	Y	Y	Y	
Biodiesel			10/31/2026				
Biodiesel			10/31/2026				Y

For additional results and summaries, see the following workbooks:

- Appendix_A_Aurora_Results_Costs_and_Resource_Selection
- Appendix_B_Build_Compare
- Appendix_C_NPV_Analysis

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PUGET SOUND ENERGY

2021 RFP: Post-Phase 2 Update

Attachment C. Financial Analysis: Ownership vs. PPA

Financial Analysis: Ownership vs. PPA

PPA vs Ownership Evaluation Model

During the negotiation period of the RFP evaluation, PSE worked with consultants of Thorndike Landing and developed the PPA vs. Ownership Evaluation Model (POEM). The POEM model is an Excel-based model that focuses on assessing the relative attractiveness of PPA versus generation asset ownership for selected generation types, including solar, wind, battery and pumped hydro storage. The model evaluates the costs/benefits to PSE customers over the terms of proposed PPAs and the useful lives of owning such generating asset technologies.

The model determines the relative cost/benefit to PSE customers over the defined timeframe including but not necessarily limited to:[1]

- For owned assets:
  - Expected capital costs
  - Fuel or charging cost (as applicable)
  - Non-fuel operating costs
  - Property tax and insurance
  - Tax incentives
  - Financing costs
  - Integration and transmission upgrade costs
  - Expected residual value
- For PPAs
  - Expected cost of power purchased under proposed PPAs
  - Impact of debt imputed under long-term contracts

The model evaluates risks of post-PPA period when a PPA's term length is shorter than the useful life of owning the asset. The model compares levelized annual cost of the PPA costs and that of the ownership costs. To quantify re-contracting risk and replacement power risk after the shorter PPA term, the model

[1] *The model is designed to compare the relative costs and benefits of the potential ownership versus PPA structures of an asset, therefore, mutual cost factors such as social cost of greenhouse gases, transmission wheeling costs, and balancing costs that do not vary due to commercial structure are considered, but not explicitly modeled.*

also compares levelized annual cost and total costs of the PPA with costs of a replacement resource to that of the ownership costs.[2]

The model also sets up the framework of the evaluation of the terminal value of owned generation that exists at the expiration of proposed PPAs. The terminal value can be determined by a percent of the project's capital cost or a multiple of the project's terminal year EBITDA. Thorndike Landing's research shows that either an 8% of a project's cost or an 8-10x EIBITA is reasonable basis for determining the terminal value.[3]

The model is also used to calculate a PPA equivalent price to compare all projects of the same technology on a levelized cost of energy (LCOE) or a leveled cost of capacity (LCOC) basis.

Key Findings and Results

The POEM analysis conducted in June 2023 considered seven projects that have both a PPA option and an ownership option. Table 1 compares the levelized cost of the PPA and ownership options for each of the seven projects. Pricing was current as of the date PSE ran the analysis. As discussed in footnote 1 on the previous page, these costs are only reflective of busbar cost.[4]

Table 1. ***Levelized cost comparison for projects with both PPA and ownership options (completed June 22, 2023)***

List	Project Name	Levelized PPA Cost ($/MWh)	Levelized Ownership Cost ($/MWh)	Cost higher/(lower) PPA – Ownership
1	[redacted]			
2	Beaver Creek Wind	[redacted]		
3	[redacted]			
4				
5				
6				
7				

[2] For example, assume both a 20-year PPA and an ownership are proposed by a bidder for a solar project. The model will compare levelized annual cost of the 20-year PPA and the 35-year ownership, and levelized annual cost of the 20 year PPA + replacement cost for 15 years and the 35 year ownership. The replacement cost can be based on a new generic solar cost or forecast market prices for year 21 to 35.

3 The 8% of capital cost is typically associated with permitting, inspection and interconnection based on an NREL study, and the 8-10x EBITDA is based on analyzing EIA data on pumped hydro storage projects.

[4] For PPAs, the model also includes the cost of imputed debt.

[5] Based on $441M development right purchase + EPC cost estimates.