Integrated Resource Plan (IRP) Stakeholder Meeting on the 2023 Electric Progress Report: Summary

v. 4/22/2022

Meeting details

- Date and time: Tuesday, March 22, 2022 from 9 a.m. to 12 p.m.
- Links to:
  - Meeting materials (e.g., hot sheet, presentations, data files)
  - Meeting recording

Action Items from March 22 Electric IRP Progress Report Stakeholder Meeting

What	When
Follow up with Katie Ware about whether PSE considers cyclical battery degradation in addition to calendar degradation and share the HDR report that cites the 2% industry average for degradation.	Included in feedback form
Follow up with Bill Pascoe on his questions on slide 42 and the cost breakdown for transmission costs.	Completed on 3/23/2022

Summary of IRP Comments and Questions during the Meeting

- **Overview**
  - PSE provided an overview of the IRP process and oriented stakeholders to the focus of the meeting: the 2023 Electric Progress Report.
  - Questions included how the timelines and processes for the Gas and Electric IRPs relate to one another.
    - PSE is not filing the Gas and Electric IRP reports together for this cycle, because on the electric-side PSE will file a progress report (rather than a full IRP).
  - See slides 7-11 in the meeting materials

- **Climate Commitment Act**
  - PSE shared an informational overview of the Climate Commitment Act, which is currently undergoing rulemaking and will go into effect in January 2023.
  - Stakeholder questions about PSE and the Climate Commitment Act included the following and were addressed in the meeting:
    - The inclusion of supply/demand and cost burden forecasts for allowance allocations in the IRP.
    - How PSE will demonstrate to the Washington Utilities and Transportation Commission (UTC) that 65 percent of no-cost allowances will be consigned to auction for the benefit of customers, prioritizing the elimination of the burden on low-income customers.
    - Reasoning for selling consigned allowances or reserving allowances for a compliance demonstration.
    - How electric utilities subject to the Clean Energy Transformation Act (CETA) will measure cost burden.
  - See slides 13-20 in the meeting materials

- **Carbon Prices and Social Cost of Greenhouse Gases**
  - PSE discussed how carbon prices affect customer bills, including externalities and direct costs to customers.
  - Stakeholder questions and comments shared in the meeting included:
    - How PSE will achieve 80 percent clean electricity by 2030, and if that is expressed as a shadow price for ratepayers.
    - If PSE is utilizing the carbon pricing method for each scenario or each sensitivity, and how that is applied throughout the planning process.
    - Why PSE does not include the social cost of greenhouse gases as direct costs, and whether PSE foresees unintended consequences in apply dispatch decisions.
    - Suggestions to only include the social cost of greenhouse gases.
    - Emphasizing the importance of accurate forecasts of the direct costs of greenhouse gases in PSE planning.
  - See slides 22-26 in the meeting materials

- **Electric Supply Side Resource Alternatives**
  - PSE shared updates on their work for Electric Supply Side Resource Alternatives, including:
    - Electric Progress Report modeling process.
    - Differences between the 2021 IRP and 2023 Electric Progress Report.
    - What PSE changed and what PSE retained from the 2021 IRP.
    - Wind and solar, energy storage, hybrid renewable resources, and thermal and emerging technologies.
    - Transmission and tariff costs.
  - Stakeholder questions and comments in the meeting included:
    - How new methodologies may impact the outcome of the 2023 Electric Progress Report.
    - Questions about PSE's assumptions around battery storage, including cycling limits and locations, and the potential benefits of battery storage and how PSE evaluates them.
    - Concerns that PSE's current models constrain the potential of battery storage.
    - Suggestions around the placement of battery storage near substations for helping address resiliency and reliability.
    - Questions and concerns about PSE's stub transmission line cost and length for battery storage facilities, and requests to see PSE calculations for a 5-mile average.
    - The importance of using the most recent available data for costs.
    - PSE's position on wind and solar resources in other states, and hybrid resources, like solar plus battery storage or wind and pumped hydropower.
    - How PSE calculates transmission costs from Montana using the Colstrip transmission line and the different transmission lines or "wheels" needed to get the power back to PSE
  - Stakeholder requests included:
    - Examples to demonstrate why PSE is considering such long stub transmission lines for battery storage facilities.
    - Granular cost data from developers and latest cost estimates from the NREL Annual Technology Baseline (ATB).

        - Transparency from PSE on future fuel resources and potential peaker plants.
    - Stakeholder suggestions included:
        - Suggestions that PSE approach resource developers directly for cost breakdowns.
        - Suggestions against strict averaging for costs.
        - Suggestions for PSE to consider holistic types of energy storage, like gravity energy storage
        - Optimizing modeling tools to select suites of clean resources to meet peak needs.
        - Focusing efforts on researching realistic resources and technologies in this IRP.
    - See slides 28-42 in the meeting materials

- **Regional Assumptions for Electric Price Forecasts**
    - PSE briefly explained what an Electric Price Forecast is, changes from the 2021 IRP, and modeling framework.
    - Stakeholder questions included:
        - Whether PSE considers projects that are already underway, or are permitted but not yet underway.
    - See slides 43-50 in the meeting materials.

Note: Stakeholder questions were addressed in the meeting or included in the Feedback Report (see next page).

Feedback Report

Purpose: The following table records the IRP stakeholder unanswered questions and PSE responses from the Electric Progress Report discussion with IRP stakeholders and the meeting's feedback form. Meeting materials are available on the project website.

Date	Stakeholder	Comment	PSE Response
3/22/22	Katie Ware	Is PSE considering cyclical degradation in addition to calendar degradation?	PSE is considering battery storage cyclical degradation by limiting the amount of cycles per day. For battery storage, PSE assumes an annual or calendar- based degradation assuming a limited amount of cycling. The augmentation for degradation is included in the fixed operations and maintenance (O&M). PSE's assumptions are based on the "Generic Resource Costs for Integrated Resource Planning" report from HDR dated Jan. 23, 2019. From the HDR report: *"Typically, integrators employ augmentation strategies such as oversizing and/or periodic replacement, to ensure that the grid connected BESS is supplying the necessary MW, MWh, and expected cycle life during the performance period. To meet electric utility customer needs, BESS integrators are willing to provide a guaranteed equipment life of about 20 years with an appropriate augmentation strategy. Each battery OEM and integrator strategy can be different and there are no set industry standards."* *Conceptual O&M Costs* *The major component of the O&M cost for a Li-ion BESS system is related to energy and capacity augmentation. Augmentation maintains the BESS capability to serve the Owner's requirement for the term of the agreement. These costs are typically covered in the fixed O&M costs. Additional fixed O&M costs typically include:* • *24x7 remote monitoring* • *Remote troubleshooting* • *Performing scheduled maintenance activities, inverter replacements, emergency and unscheduled maintenance support* • *Periodic reporting, training and continuous improvement* • *Software licensing and updates* • *HVAC maintenance* • *Auxiliary electrical loads* • *Landscaping* • *Mechanical/electrical inspections and updates"*

<table>
<tr><th>Date</th><th>Stakeholder</th><th>Comment</th><th>PSE Response</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th rowspan="2">Conceptual O&M Costs</th><th>Fixed O&M</th><th>Variable O&M</th></tr>
<tr><th>$/kW-yr</th><th>$/MWH</th></tr>
<tr><td>25 MW Li-Ion (2 Hour)</td><td>$20.54</td><td>$0.00</td></tr>
<tr><td>25 MW Li-Ion (4 Hour)</td><td>$32.16</td><td>$0.00</td></tr>
<tr><td>25 MW Flow (4 Hour)</td><td>$30.80</td><td>$0.00</td></tr>
<tr><td>25 MW Flow (6 Hour)</td><td>$40.27</td><td>$0.00</td></tr>
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<tr><td>3/22/22</td><td>Katie Ware</td><td>Do you have a source on hand for the lithium battery degradation?</td><td>Battery degradation is dependent on the number of cycles and state of the battery’s charge. Deep discharge will hasten the degradation of a lithium-ion battery. All of the bids in the All-Source Request for Proposal (RFP) reflect various versions of over-build and augmentation. There is no set standard. Including the augmentation in the fixed O&M appears reasonable given what we are seeing in the RFP.

In the 2017 IRP, PSE used a 2% degradation on the battery energy storage per year, meaning the total available capacity of the battery decreased 2% each year until end of life. The 2017 IRP can be found at pse.com/irp: PSE IRP - Past IRPs 2017 In the 2019 IRP process and the 2021 IRP, PSE moved to augmentation in the fixed O&M. So, no degradation was modeled, and the fixed O&M was increased for augmentation. The discussion from the HDR report is included above.

PSE will continue with augmenting cost for the 2023 progress report as opposed to a degradation of capacity</td></tr>
<tr><td>3/22/22</td><td>Don Marsh</td><td>I agree that 5 miles of transmission for battery installations is too long. Even 1 mile seems questionable. Can we ask for no more than 1/2 mile? Or could PSE show us why a 5-mile average is reasonable for our energy grid?</td><td>Thank you for this feedback. IRP staff reviewed generating resource interconnection assumptions and costs with PSE System Planning and are updating our assumptions, including the cost per mile for interconnection transmission lines. Also, in reviewing the assumptions for the National Renewable Energy Lab (NREL) Annual Technology Baseline (ATB) costs, we found that the costs only cover "inside the fence” meaning just the generic resource costs and construction and do not cover transmission lines or substation for interconnection. PSE is reviewing historic project costs over the last 5 years and will present the updated information at the June 6, 2022, meeting on Delivery System Planning.</td></tr>
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			We are also reviewing interconnection requests in the queue and information submitted to the All-Source RFP for the length of the transmission line for interconnection. This update will be for all generic resource alternatives, not just battery storage.
3/22/22	Fred Heutte	My comment is that strict averaging is not preferable. PSE should use the most relevant and up to date data to assess resource costs and might have different weighting of cost sources for different resource types as a result. The ATB is an excellent starting point for both current costs and future trajectories, but where other relevant data indicates a difference, it should be considered, including from PSE's RFPs. However this is done, PSE should explain the approach taken. Perfect information isn't needed for modeling, but a sensible approach will identify best-available cost and performance inputs.	Thank you for this feedback. PSE will use the National Renewable Energy Lab's Annual Technology Baseline 2021 Report (2021 NREL ATB) for resource costs for the 2023 Electric Progress Report. Additionally, PSE has compared the NREL ATB 2021 costs with responses to the 2021 All-Source RFP. As noted in PSE's 2021 Clean Energy Implementation Plan (CEIP): *"The NREL ATB cost assumptions are generally lower for most resources than the costs in PSE's 2021 IRP or the range of bids received in the All-Source RFP. However, it is difficult to compare the generic utility-built and owned resources modeled in the IRP to the PPAs from the All-Source RFP due to the differences in financing, tax incentives, returns, and various cost assumptions including transmission, interconnection, and operational costs. In general, NREL ATB's cost assumptions appeared to be closer to the range of bids received in the All-Source RFP than to the IRP generic resource cost assumptions. PSE bases the premise that NREL ATB cost assumptions are directionally closer to the All-Source RFP solely on the company's preliminary analysis conducted during the Draft CEIP comment period. PSE plans to examine these cost assumptions in more detail and make better-informed assumptions in the next IRP."*
3/22/22	Katie Ware	Hydrogen - Re: the partnership with Mitshubishi for a "Green Hydrogen Standard Package," is PSE looking to source the energy directly through hydro or have it be grid-charged somewhere closer to load?	Clean alternative fuels, like green hydrogen, will play a critical role in the clean energy future, which is why PSE is taking steps to research these new technologies, conduct pilots and develop our expertise in this area. It is not known at this time whether green hydrogen would be used to generate power and/or blended into the existing gas distribution system, PSE is looking into both end uses of hydrogen. In May 2021, PSE signed a joint development agreement with Mitsubishi Power to develop hydrogen gas turbine facilities as well as explore opportunities for green hydrogen production, storage, transportation, and utility scale battery storage systems.
3/22/22	James Adcock	Battery Overbuild: Has PSE Confirmed with ATB that they haven't already applied the 20% overbuild in their pricing?	Please refer to the response later in this report addressing Mr. Adcock's broader follow-up questions from 4/1/22.

Date	Stakeholder	Comment	PSE Response
3/22/22	Bill Pascoe	Slide 42 - What is the basis for the additional transmission cost for MT wind? Slide 42 - Will you consider sharing transmission for MT wind & PSH? Slide 42 - Is PSE's full CTS capacity considered to be available for new resource in 2025 assuming closure of Colstrip 3&4?	We are using the same assumptions as the 2021 IRP. Once PSE removes Colstrip 3 & 4 from the portfolio, PSE assumes the transmission will be available for wind and pump storage hydro (PSH) or hybrid of both resources from Montana. PSE reviewed the details of the transmission cost with Mr. Pascoe and he gave feedback that the scheduling (SCD) rate should not be applied to the Montana Intertie rate, and he is correct. PSE has made the adjustment and the updated transmission cost from Montana is $61.73/kw-yr instead of the $64.63/kw-yr presented on March 22.
3/22/22	Anne Newcomb	Following up with Bill's question…if renewable projects are complete will PSE bring the Clean energy online prior to the end of 2025 as Colstrip in required to go offline?	Currently, there is no available capacity on the transmission line to bring additional renewable resources over from Montana until Colstrip retires. PSE does plan to acquire additional renewable resources through the All-Source RFP.
3/22/22	Anne Newcomb	Are you looking at Gravity Storage like lifting and lowering bricks or mobile masses made from recycled and locally sourced materials? I would like to see this looked at as much as possible. energyvault.com looks like an excellent company to work with for innovative practical storage needs and has a CA location. gravitricity.com looks great and promotes moving gravity storage underground but may not have a local location.	Thank you for sharing your thoughts and resources on gravity storage. Right now, the main gravity storage resources available in the US is pumped storage hydropower. Looking into this, we did not find publicly available data that we can use for additional types of gravity storage. For now, PSE plans to use costs for pumped storage hydro. If stakeholders have additional cost resources to suggest, please share them. We've been looking into liquid air and compressed air storage. Avista studied liquid air and we're considering doing the same.
3/22/22	Katie Ware	I'll also add to what Fred was saying re: hybrid resources. We hope to see PSE finding new ways to optimize its modeling tool, specifically by forcing it to select a suite of clean storage resources to meet peak needs (vs. comparing each resource individually). I understand PSE is considering new modeling tools for potential use in a future IRP to (in part) get at this issue.	Thank you for the suggestion to model suites of clean storage resources as opposed to comparing each resource individually. PSE understands the motivation of this suggestion to mean that a suite, or group of resources, may provide a portfolio level of benefits that is not captured by modeling resources as isolated units. PSE agrees that portfolio level interactions are often more important than individual resource characteristics. These portfolio level interactions are already incorporated into PSE's existing capacity expansion modeling software, Aurora. While resources are enumerated on an individual basis, the capacity expansion model is performed in an iterative manner and solved to minimize cost for the entire portfolio, allowing the model to evaluate and optimize how a group of resources contributes to the portfolio. Furthermore, PSE does include hybrid resources which include a generator and storage resource, co-located to take advantage of certain shared capital costs. If there are

Date	Stakeholder	Comment	PSE Response
			recommendations for other hybrid or co-located resources PSE is open to recommendations.
3/22/22	Joni Bosh	Slide 46 - Does PSE consider projects that are permitted and or permitted/underway, but not yet finished? Would the project be by generator/by state?	PSE may consider projects that are in the permitting process if at least two "Advanced Development" criteria are met, indicating a high likelihood that the project will reach completion. PSE uses the term "Advanced Development" as a criterion for adding a new project to the Western Electricity Coordination Council (WECC) for the regional electric price forecasting. Advanced Development is defined in accordance with the S&P Global power plant database and is achieved when two of the following five criteria are met: financing in place; power purchase agreement signed; turbines secured; required permits approved; or contractor signed on to the project. S&P Global is a subscription service that combines publicly available data from EIA, EPA, FERC and web scrapings into one database. In addition to these existing new projects, generic renewable resources will be added to the system to meet all the renewable requirements. Details on the regional new builds and retirements were posted as an Excel file ("2023 Electric Progress Report – Regional New Builds and Retirements") to the 2023 IRP website ahead of the March 22, 2022, meeting and may be accessed at pse.com/irp. The projects are categorized by both generator type and by state.
4/1/22	Climate Solutions	We urge PSE to make sure that the electric and gas IRP processes are integrated holistically to ensure that what's being considered on the gas side – particularly around the potential for electrification to be a cost-effective decarbonization strategy – can be incorporated into the electric IRP, and vice versa. We see a strong interaction between the demand forecasts for each side of the utility as well as the Conservation Potential Assessments.	While scenarios will not be included as part of the Electric Progress Report, PSE does plan to evaluate the demand forecast impacts from the gas scenarios on the electric system in the 2023 Gas Utility IRP. This will include electric portfolio runs through Aurora, and the write up and analysis will be included in the Gas Utility IRP. While PSE has the technical capability to do both sides of this analysis, at least for PSE's electric and PSE's gas service territory, the interrelated nature creates a significant challenge for this analysis. Approximately half of PSE's gas customers take electric service from another electric utility, so this is a clear limitation to being able to do an entirely holistic analysis. In this two-year planning cycle, we will do an analysis of both sides consistently. This will provide useful information for both electric and gas resource plans, for policy makers, and provide lessons learned for how to further improve the integration process in future IRPs.

Date	Stakeholder	Comment	PSE Response
4/1/22	Climate Solutions	Regarding slide 20, which discusses the requirements for gas utilities under the Climate Commitment Act (CCA) – we would like to see more clarity around how PSE plans to model these scenarios to look at consignment of allowances versus using the allowances for CCA compliance. Additionally, for allowances that are auctioned, the IRP should describe how those revenues will be used to benefit customers, particularly in prioritizing mitigation of rate impacts to low-income customers as mandated by the law.	Thank you for your question about how PSE will consider CCA compliance for our gas utility. The 2023 Gas Utility IRP will be a higher-level look at CCA compliance. Specifically, PSE will examine how the CCA affects the mix of cost-effective conservation, renewable gas, and natural gas resource plus greenhouse gas allowance alternatives. Additionally, as discussed during the March 31, 2022 meeting on the 2023 Gas Utility IRP, PSE will be examining how a scenario where allowances in excess of the free allowances from the Washington Department of Ecology (Ecology) are not available would affect the least cost mix of supply-side and demand-side resources, along with potentially other scenarios. The rules for CCA are still being developed so some of the detailed compliance considerations, like auction revenue and rate impacts, have yet to be addressed. Developing detailed CCA compliance plans as referenced in this question is more detailed than would be addressed in an IRP.
4/1/22	Climate Solutions	Regarding slide 25 – as other stakeholders mentioned during the meeting, we are concerned about the included cost of a five-mile interconnection spur line for batteries. Appropriate battery siting should ideally reduce the need for transmission lines of this length.	Please refer to the response to a similar question from Mr. Marsh from 3/22/22.
4/1/22	Climate Solutions	Regarding slide 32 – PSE stated during the meeting that to account for lithium ion battery degradation, PSE has augmented costs to account for 2% degradation from normal wear and tear. We would like to see some clarity on what the percentage change is measuring – is it capacity degradation, fixed operations and maintenance increases, or capital expenditure increases?	Typically, integrators employ augmentation strategies such as oversizing and/or periodic replacement, to ensure that the grid connected battery energy storage systems (BESS) is supplying the necessary MW, MWh, and expected cycle life during the performance period. To meet electric utility customer needs, BESS integrators are willing to provide a guaranteed equipment life of about 20 years with an appropriate augmentation strategy. Each battery original equipment manufacturer (OEM) and integrator strategy can be different and there are no set industry standards.
4/1/22	Climate Solutions	Regarding slide 32 –We would also like more information on how the 2% rate was chosen – Lazard's Levelized Cost of Storage Analysis uses a 2.6% Degradation rate per annum for wholesale storage.	Lazard's degradation rate is higher than what we're assuming. PSE's 2% rate is based on the HDR report and includes augmentation for degradation in fixed O&M.
4/1/22	Climate Solutions	Regarding page 42 – for those costs not available from NREL, PSE could communicate directly with developers to find average cost estimates.	PSE appreciates stakeholders' suggestions that we reach out to developers to determine the average resource cost. We have based our resource cost estimates using publicly-available data, which is in response to feedback from IRP stakeholders during the 2019 IRP process. At that time, PSE had hired HDR to do research on costs and we received

Date	Stakeholder	Comment	PSE Response
			comments from stakeholders to use publicly-available information for resource costs and operating assumptions to maintain transparency. For the 2023 Electric Progress Report, PSE will use the 2021 NREL ATB as there is not adequate time in the schedule to gather resource cost data from developers. Please note that in fall 2021 PSE compared the 2021 NREL ATB costs with our All-Source RFP bids. At that time, in general, NREL ATB's cost assumptions appeared to be directionally closer to the range of bids received in the All-Source RFP. Understanding that stakeholders have shared differing feedback over the years on sources for resource cost, PSE will consult with IRP stakeholders in late 2023 to develop an approach for gathering resource cost data for use in the 2025 IRP.
4/1/22	James Adcock	The following issues re PSE modeling of "Utility Scale Batteries" have come up several times already without clarity or closure. I suggest these modeling issues actually need to get "nailed down." 1. Is it necessary and appropriate that PSE adds an addition 20% capacity (IE increase battery costs by 20%) to account for 100% capacity usage aka discharge to "0%" -- or has ATB already added this 20% internally to their battery modeling? 2. Is there really something somehow unique about PSE as a utility as compared to their peer utilities, where their peer utilities can somehow always figure out a way to attach Utility Scale Battery Storage with minimal "stub lines" -- a few hundred feet -- whereas in comparison PSE continues to insist that there is nowhere anywhere in their 6,000 square miles of service area where such an interconnect could be made without an expensive and unproductive 5-mile-long stub line? Further, I suggest, per the discussion with Phillip Popoff, that it is time to stop the pretext that PSE is planning to build "hydrogen peakers" or "biodiesel peakers" -- but rather, and let us just be	Thank you for your feedback, which we've addressed below by topic. 1. Overbuild lithium ion cell capacity to allow for complete discharge (0% State of Charge) operation of batteries. PSE plans to include a 20% adder to the storage capacity component of the batteries modeled in the 2023 Electric Progress Report. The 20% adder is intended to 'overbuild' the energy capacity of the battery to allow the cell to be discharged for the intended duration of the battery (i.e. a 4-hour battery would be able to discharge for a full 4 hours). For example, if 100 MWh is needed, then the battery will be built to 120 MWh. This is in contrast to the operation of batteries in past IRPs, which limited batteries to discharge to a minimum state of charge (SOC) of 20%. The 20% minimum SOC operating parameter was modeled to limit accelerated degradation of battery cells caused by complete discharge (0% SOC). Evidence of the impacts of complete battery discharge may be reviewed in the work by The Electrochemical Society[1]. For the 2023 Electric Progress Report, PSE plans to use the 2021 NREL ATB to represent capital costs of generic resources, including batteries. The NREL ATB representative technology does not include any overbuild assumptions for its battery

[1] Degradation-Safety Analytics in Lithium-Ion Cells: Part I. Aging under Charge/Discharge Cycling - IOPscience and Degradation of Commercial Lithium-Ion Cells as a Function of Chemistry and Cycling Conditions - IOPscience

Date	Stakeholder	Comment	PSE Response
		open and honest about this, PSE is planning to build bog-standard natural gas peakers that will run "all the time" on natural gas, except over time will dispatch less frequently due to actual imposed carbon costs, and then after 2045, I guess, "never" actually dispatch except for an emergency, or it they can actually, eventually, actually be run on hydrogen or biodiesel respectively. Let's actually be open and honest about this so we can double-check that we really understand what it means, and that we are not doing something stupid, and we're not doing it because PSE has introduced errors in their modeling of Utility Scale Batteries, and the best and highest actual use of those thereof. Finally, I ask that the facilitator do a self-check that she is actually acting in practice in a PSE-independent mode towards the best interests of all participants.	cost estimates. For example, the 4-hour lithium battery has a nameplate capacity of 60 MW and an energy storage capacity of 240 MWh[2]. The energy storage capacity is equal to the duration of the battery times the nameplate capacity; an overbuild battery would have an energy storage capacity greater than the duration times the nameplate capacity. Therefore, the cost must be adjusted to include additional energy storage capacity. PSE has supplied the cost adjusted assumption on the PSE website[3]. The 20% overbuild adjustment in cell G8 being applied only to the "storage block" component of a battery and not to the other components of the capital cost. 2. As noted in an earlier response to Mr. Marsh's question from 3/22/22, PSE is updating its assumptions on stub lines and will present this information at the June 6, 2022, IRP stakeholder meeting. 3. PSE will be modeling peaking plants that are fully capable of burning multiple fuels - carbon-free gas, renewable biodiesel and fossil fuels until alternative fuel infrastructures are developed to ensure new plants will be fully CETA compliant by 2045. We do not want to plan on building power plants that will be obsolete by 2045. The IRP is a process that assesses options, and we're looking at all options. The IRP model selects the lowest-reasonable cost and least-risk action that complies with CETA and CCA, which we use to help us make decisions about resources that may be procured in the future. 4. Triangle Associates, the neutral third-party facilitator, followed up with Mr. Adcock to understand the concerns and shared resources for him to reach out with any additional feedback.
4/1/22	James Adcock	1. PSE stop adding the 20% battery-upsize costs unless they can prove that ATB has not already done so. 2. PSE stop adding the 5-mile stub line costs and rather assume that there is somewhere in their 6,000 square mile	Thank you for this additional comment. Please see the previous response, which addresses these comments.

[2] Utility-Scale Battery Storage | Electricity | 2021 | ATB | NREL
[3] https://oohpseirp.blob.core.windows.net/media/Default/2022_meetings/2022_03/2023_ElectricProgressReport_GenericResourceCostAdjustments.xlsx

Date	Stakeholder	Comment	PSE Response
		service area where they can in fact "direct connect" Utility Scale Batteries without the added 5-mile stubline costs. 3. That PSE simply start talking openly and honestly with participants about how PSE is planning to add new bog-standard natural gas peakers (and perhaps Combined Cycle) to their system, rather than pretending these things are going to be running off hydrogen or biodiesel. 4. That the facilitator self-checks and makes sure she is actually acting independent of PSE in the best interest of all participants.	
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	I. INTRODUCTION Renewable Northwest thanks Puget Sound Energy ("PSE") for this opportunity to provide feedback as a stakeholder in PSE's 2023 Electric Integrated Resource Plan ("IRP") Progress Report. This feedback is a response to PSE's March 22, 2022, IRP stakeholder meeting regarding the Climate Commitment Act ("CCA"), electric supply side resource alternatives, and regional assumptions for the electric price forecast. We are still reviewing the work that has been done to date in the Department of Ecology's rulemaking to implement the CCA, so we will not be commenting on that portion of PSE's IRP presentation. If we have thoughts on the CCA-related material PSE has presented, we will be sure to submit that feedback along with any other feedback from PSE's Gas Utility IRP stakeholder meeting on March 31, 2022, by the April 8 deadline. These comments focus mostly on PSE's selection of proxy resources to inform its portfolio modeling, a couple additional considerations regarding battery energy storage systems ("BESS") and hybrid resources, and the sourcing of accurate pricing for generic resources. We appreciate PSE's incorporation of stakeholder feedback from its previous IRP cycle, and we look	Thank you for sharing this feedback.

Date	Stakeholder	Comment	PSE Response
		forward to continued collaboration with the company during the development of this progress report.	
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	II. FEEDBACK Renewable Northwest appreciates the addition of new proxy renewable resources to PSE's IRP modeling. Other utilities throughout the Northwest are identifying significant value in adding geographically and technologically diverse renewable resources to their systems, especially as these resources continue to fall in cost. For this reason, we agree with other stakeholders that PSE should not be looking to remove its CETA-compliant proxy resources at this time (e.g., Wyoming and Idaho solar), but expand them.	PSE agrees and has decided to retain Wyoming and Idaho solar as generic resources for the 2023 Electric Progress Report.
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	We appreciate the changes to PSE's proxy energy storage resources, and we think PSE should also model an 8-hour Li-ion battery configuration (or an 8-hour consolidated battery technology, to align with NREL's cost information). Long-duration energy storage resources will be key to unlocking the value of large-scale renewable energy procurement brought on by the Clean Energy Transformation Act ("CETA"). They would also add value by providing capacity in the dual peaks (early morning & late evening) that PSE sees in its system. Recently, California Community Power ("CC Power"), a Joint Powers Agency representing a group of ten Community Choice Aggregator energy suppliers in the state, announced that it would procure an 8-hour utility-scale Li-ion battery project called Tumbleweed which will have a 69-MW output and 552 MWh of capacity.[1] *See, e.g.*, "California Community Power members procure 69MW of long-duration storage." *PV Magazine* (Jan. 26, 2022), *available at* https://pv-magazine-usa.com/2022/01/26/california-community-power-members-procure-69mw-of-long-duration-storage/.	PSE appreciates the value of longer duration storage technologies and is already modeling pumped storage hydro with a storage duration of 8-hours. If time allows, PSE will attempt to also include an 8-hr Li-Ion battery in the 2023 Electric Progress Report but may have to incorporate this suggestion into future IRP cycles.
3/31/22	Katie Ware & Sashwat Roy,	We appreciate PSE taking a proactive approach in modeling multiple configurations of hybrid resources. Specifically, we support the inclusion of a high solar-to-battery ratio being	Thank you for the recommendation to use additional generation-to-storage ratios while modeling hybrid resources. PSE observed that a generation-to-storage ratio of 2:1 was, by far, the most common configuration of hybrid resources and selected that configuration

Date	Stakeholder	Comment	PSE Response
	Renewable Northwest	considered in this IRP. However, we encourage PSE to also consider a 1:1 generation-to-storage capacity ratio (i.e. 100 MW PV paired with 100 MW 4-hour BESS). Increasing the generation-to-storage ratio may provide increasing value in certain situations – especially in regions rich with solar resources – by charging the batteries to provide capacity during high-demand hours and also maximizing the capacity value for a specific point of interconnection ("POI") limit. PacifiCorp, in its recent 2023 IRP public input meeting, realized the value of 1:1 configuration and selected this configuration in their generic resources assumptions.[2] Thus, we recommend PSE consider both 2:1 and 1:1 generation-to-storage ratios for this IRP progress report. 2 PacifiCorp 2023 Integrated Resource Plan. Public Input Meeting #1. https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2023-irp/PacifiCorp_2023_IRP_PIM_February_25_2022.pdf	for use in the 2023 Electric Progress Report. Due to time constraints, PSE is not able to include other hybrid resource configurations as part of the 2023 Electric Progress Report but will consider including additional generation-to-storage ratios in future IRP cycles.
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	PSE should also take proactive efforts in modeling DC-coupled hybrid resources in its capacity expansion modeling. DC-coupled hybrid resources provide an opportunity to capture clipped energy by increasing the inverter loading ratios (ILR of 1.5 or more), thereby capturing more value from solar energy during times when the production is maximum and shifting it to the battery storage for dispatch during evening and early morning. NREL and other national labs have resources available for PSE to tap into to ensure that the generic resource assumptions for DC-coupled storage reflect the current market in the US.[3] 3Representing DC-Coupled PV+Battery Hybrids in a Capacity Expansion Model. NREL, 2021 https://www.nrel.gov/docs/fy21osti/77917.pdf	PSE already incorporates elements of DC-coupled solar-storage hybrid resources in its capacity expansion modeling including shared inverter and balance of plant costs and eligibility of Investment Tax Credit benefits (ITC) for storage capital costs. Thank you for sharing the NREL report on the added value of increasing the inverter load ratio (ILR) of DC-coupled systems. PSE recently completed work on updating its wind and solar generation profiles for the 2023 Electric Progress Report and assumed an ILR of 1.3. Changing this assumption for hybrid resources is not possible for the 2023 Progress Report due to time constraints, but PSE will consider this information for future IRPs.
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	We appreciate PSE updating the capital cost assumptions for solar, wind, and energy storage resources. All of these resources are seeing significant declines in capital costs as we go down in the learning curve with economies of scale. We also appreciate PSE considering our recommendation and changing the battery state-of-charge ("SoC") parameters to allow Li-ion batteries to discharge fully (i.e. to 0% SoC). However, we are concerned with the 20% cost multiplier added to enhance the	PSE has reviewed the assumptions of the 2021 NREL ATB for batteries and found no evidence that assumptions include enhanced capacity to account for complete discharge (0% SOC) of Li-Ion batteries (i.e. the 4-hr 60MW battery has an energy capacity of 240 MWh). Therefore, PSE has included a 20% adder on only the 'storage block' component (i.e. the battery cells) of the capital cost of Li-Ion batteries. Other capital cost components such as balance of plant, controls, development costs, etc have not been modified by the 20%

Date	Stakeholder	Comment	PSE Response
		battery capacity.4 As per our understanding, battery manufacturer warranties cover those costs in the supply contract by enhancing the battery capacity (i.e. increasing capacity from 200 MWh to 210 MWh). Adding a 20% cost multiplier seems excessive and may artificially tilt resource selection away from cost-effective storage resources resulting in selection of a portfolio with a higher net present value of revenue requirements ("NPVRR"), thereby increasing customer costs. We recommend reducing the multiplier to the range of 5-7% to ensure that the excess capacity is accounted for in overall costs.	adder. The cost modification process has been documented in the Excel workbook "2023 Electric Progress Report – Generic Resource Cost Adjustments" available online at pse.com/irp. For example, the change in total capital cost for a 4-hr Li-Ion battery increases from $1466/kW to $1592/kW, about 9%.
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	During the March 22 stakeholder meeting, PSE solicited feedback on how it should model generic resource costs that are not reflected in NREL's latest Annual Technology Baseline ("ATB"). Renewable Northwest continues to recommend that utilities use both NREL ATB data *and* bid information acquired through the most recent all-source request for proposals ("RFP") to calculate generic resource costs, depending on which data point is most recent. Other industry resources including Lazard's Levelized Cost report may also be helpful. For resources which are nascent or if there is a lack of publicly available data, we recommend contacting national laboratories like NREL and the Pacific Northwest National Laboratory ("PNNL") that are actively researching these emerging technologies and/or project developers themselves. These options will better inform PSE's modeling than information obtained from third-party vendors who have significantly less experience with these technologies.	Thank you for the recommendation on approaches for obtaining cost projections for generic resource costs. PSE will continue to obtain and/or solicit information from national laboratories, public sources (Lazard, Energy Information Administration, etc) as well as project developers. PSE cannot use bid information from recent All-Source Requests for Proposal (RFPs) due to confidentiality requirements. Furthermore, many bids to the most recent RFP are in the form of Power Purchase Agreements (PPAs) which do not align with the self-build assumption of resources included in the integrated resource planning process.
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	Finally, we recommend that PSE not use the fixed and variable operation & maintenance cost ("FOM" and "VOM") assumptions from the HDR report that significantly inflated the capital costs for solar, wind, and energy storage resources in the 2021 IRP. In the 2021 IRP, solar + battery configurations were assumed to be $2464/kW which was exorbitant compared to the 2023 Draft Progress Report value of $1255/kW, and relying on third–party vendors could itself significantly overstate FOM and VOM values. PSE could take these values from NREL's ATB and add a reasonable multiplier to reflect their operating conditions.	PSE is investigating historic operating costs, as documented by FERC Form 1, and will evaluate how the historic costs compare to the HDR Report and the 2021 NREL ATB operating costs. PSE will keep stakeholders apprised of the results of the study and the costs which will be used for the 2023 Electric Progress Report.

Date	Stakeholder	Comment	PSE Response
3/31/22	Katie Ware & Sashwat Roy, Renewable Northwest	III. CONCLUSION Renewable Northwest thanks PSE for its consideration of this feedback. We look forward to continued engagement as a stakeholder in this 2023 IRP process.	Thank you for your feedback.

Feedback Addressed from March 22 IRP Stakeholder Meeting & Feedback Forms

What PSE Heard	What PSE Did with Feedback (to date)
Including externality costs, such as the social cost of greenhouse gases, in resource planning is important.	PSE includes the social cost of greenhouse gas as an externality cost in all of its resource planning processes and plans to also include a direct cost of carbon to model the impacts of the Climate Commitment Act.
Consider placing battery storage in critical areas to power emergency services and hospitals in the event of a natural disaster.	PSE does not include specific project siting assumptions as part of the IRP; however, the 2023 Progress Report will include distributed batteries as a generic resource which may be used for grid resiliency.
Include actual cycling costs and battery degradation as factors in the models for battery cycling.	PSE will research the possibility of including energy storage cycling costs into its production cost models.
Use the most recent data possible when comparing resources.	PSE will use the NREL ATB 2021 Report. If there are other publicly-available resource cost data sources, PSE welcomes that input from stakeholders. But given the progress report timeline, PSE will need to finalize the assumptions by June 2022.
Consider using holistic types of energy storage (i.e. gravity energy storage).	PSE is modeling pumped storage hydro which is a gravity energy storage resource. There is limited public information on other energy storage resources, but we will continue to explore more options as part of the 2025 IRP. Please refer to Feedback Report for details.
5 miles of stub transmission for battery storage is too long.	PSE is updating its assumptions on stub line lengths for all resources. PSE will present an update at the June 6, 2022, meeting. Please refer to Feedback Report for details.
Consider going straight to resource developers for cost breakdowns.	For the 2023 Electric Progress Report, PSE will use the NREL ATB 2021. Understanding that stakeholders have shared differing feedback over the years on sources for resource cost, PSE will consult with IRP stakeholders in late 2023 to develop an approach for gathering resource cost data for use in the 2025 IRP. Please refer to Feedback Report for details.
Strict averaging for resource costs is not preferable, and PSE should explain their approach.	PSE will use the NREL ATB 2021 Report. Please refer to Feedback Report for details.

What PSE Heard	What PSE Did with Feedback (to date)
Consider solar and a two-hour battery and solar and a 6-8-hour battery to see the resource values they provide.	PSE observed most of the bids for hybrid resource in the 2021 All-Source RFP to be 4-hr duration batteries and plans to model that configuration. PSE will consider including other configurations in future IRP cycles.
Optimize the modeling tool to force it to select a suite of clean storage resources to meet peak needs rather than comparing resources individually.	PSE agrees and these interactions are already incorporated into the modeling tool (Aurora). Please refer to the feedback form for details.
Be transparent with plans for peaker plants.	PSE agrees and continues to keep IRP stakeholders informed on our All-Source RFP and engaged with development of the 2023 Electric Progress Report. Please refer to Feedback Report for details.
Pace investigations into small nuclear or hydrogen and target resources practically during this IRP cycle.	PSE intends to include hydrogen and small modular nuclear reactors as generic resources in the 2023 Electric Progress Report. PSE expects assumptions around these resources to evolve in future IRPs as more is learned about these emerging technologies.
Retain Wyoming and Idaho solar in the IRP model, rather than remove them	PSE agrees and has decided to retain Wyoming and Idaho solar as generic resources for the 2023 Electric Progress Report.
Suggest modeling an 8-hour Li-ion battery configuration (or an 8-hour consolidated battery technology, to align with NREL's cost information)	PSE is already modeling pumped storage hydro with a storage duration of 8-hours. If time allows, PSE will attempt to also include an 8-hr Li-Ion battery in the 2023 Electric Progress Report but may have to incorporate this suggestion into future IRP cycles. Please refer to Feedback Report for details.
Consider both 2:1 and 1:1 generation-to-storage ratios for this IRP progress report.	PSE observed that a generation-to-storage ratio of 2:1 was, by far, the most common configuration of hybrid resources and selected that configuration for use in the 2023 Electric Progress Report. Due to time constraints, PSE is not able to include other hybrid resource configurations as part of the 2023 Electric Progress Report but will consider including additional generation-to-storage ratios in future IRP cycles. Please refer to Feedback Report for details.
Take proactive efforts in modeling DC-coupled hybrid resources in its capacity expansion modeling. DC-coupled hybrid resources provide an opportunity to capture clipped energy by increasing the inverter loading ratios	PSE already incorporates elements of DC-coupled solar-storage hybrid resources in its capacity expansion modeling including shared inverter and balance of plant costs and eligibility of Investment Tax Credit benefits (ITC) for storage capital costs.

What PSE Heard	What PSE Did with Feedback (to date)
(ILR of 1.5 or more), thereby capturing more value from solar energy during times when the production is maximum and shifting it to the battery storage for dispatch during evening and early morning	PSE recently completed work on updating its wind and solar generation profiles for the 2023 Electric Progress Report and assumed an ILR of 1.3. Changing this assumption for hybrid resources is not possible for the 2023 Progress Report due to time constraints, but PSE will consider this information for future IRPs. Please refer to Feedback Report for details.
Concern about the 20% cost multiplier added to enhance the battery capacity, and recommendation to reduce the multiplier to the range of 5-7% to ensure that the excess capacity is accounted for in overall costs	PSE has reviewed the assumptions of the 2021 NREL ATB for batteries and found no evidence that assumptions include enhanced capacity to account for complete discharge (0% SOC) of Li-Ion batteries (i.e. the 4-hr 60MW battery has an energy capacity of 240 MWh). Therefore, PSE has included a 20% adder on only the 'storage block' component (i.e. the battery cells) of the capital cost of Li-Ion batteries. Other capital cost components such as balance of plant, controls, development costs, etc have not been modified by the 20% adder. The cost modification process has been documented in the Excel workbook "2023 Electric Progress Report – Generic Resource Cost Adjustments" available online at pse.com/irp. For example, the change in total capital cost for a 4-hr Li-Ion battery increases from $1466/kW to $1592/kW, about 9%. Please refer to Feedback Report for details.
Recommend utilities use NREL ATB data, bid information, and Lazard's Levelized Cost report for resource costs, and for those not included to reach out to NREL and PNNL and project developers.	PSE will continue to obtain and/or solicit information from national laboratories, public sources (Lazard, Energy Information Administration, etc) as well as project developers. PSE cannot use bid information from recent All-Source Requests for Proposal (RFPs) due to confidentiality requirements. Please refer to Feedback Report for details.
Recommend that PSE not use the fixed and variable operation & maintenance cost ("FOM" and "VOM") assumptions from the HDR report that significantly inflated the capital costs for solar, wind, and energy storage resources in the 2021 IRP	PSE is investigating historic operating costs, as documented by FERC Form 1, and will evaluate how the historic costs compare to the HDR Report and the 2021 NREL ATB operating costs. PSE will keep stakeholders apprised of the results of the study and the costs which will be used for the 2023 Electric Progress Report. Please refer to Feedback Report for details.

IRP Stakeholder Attendees (alphabetical by first name)

1. Aaron Tam, Attorney General
2. Andrew Hooper, Zoom
3. Anne Newcomb, IATC
4. Austin Nnoli, GE
5. Bill Pascoe, Pascoe Energy
6. Bill Will, WASEIA
7. Brian Grunkemeyer, FlexCharging
8. Chelsea Talbert, Pierce County
9. Christopher Doyle, 1099 Energy
10. Cuong Nguyen, Energy Analytics
11. Daniel Handal, NEE
12. David Branchcomb, SPI
13. David Tomlinson, Solar Horizon
14. Deepa Sivarajan, Climate Solutions
15. Don Marsh, Sierra Club
16. Fred Heutte, NWEC
17. James Adcock
18. James Doone, ES Volta
19. Jeffrey Larsen
20. Jennifer Snyder, UTC
21. Jim Schretter, Beacon Energy
22. Joel Carlson
23. John Fazio, NWPCC
24. Jon Lange, Sun Energy Systems
25. Joni Bosh, NWEC
26. Katie Ware, Renewable NW
27. Larry Becker, Frontier
28. Lauren McCloy, NWeC
29. Lauren Batalias, King County
30. Markus Virta, Western Solar Inc
31. Michael Mullaly, Monolith Energy
32. Michael Berry, Q Cells
33. Monica Blakeslee-Kish, Energy Solution
34. Nelli Doroshkin, INV Energy
35. Nora Hawkins, UTC
36. Patrick Leslie, Monolith Energy
37. Paul Lekan, Armada Power
38. R.Court Olson, Optimum Building
39. Rachel Clark, City of Tacoma
40. Randy Hardy, Hardy Energy
41. Rosemary Moore
42. Semra Riddle, City of Lake Forest Park
43. Stacy Vynne McKinstry, City of Issaquah
44. Stephanie Chase, Attorney General
45. Tracy Furutani, City of Lake Forest Park
46. Virginia Lohr
47. Willard Westre

Puget Sound Energy Staff Observers (alphabetical by first name)

1. Alexandra Karpoff
2. Allison Jacobs
3. Anthony O'Rourke
4. Bob Williams
5. Brett Rendina
6. Brian Tyson
7. Cindy Vu
8. Colin Crowley
9. Corey Corbett
10. David Meyer
11. Diann Strom
12. Doug Hart
13. Elizabeth Hossner
14. Gurvinder Singh
15. Heather Mulligan
16. Jennifer Coulson
17. Jesse Durst
18. Jessica Zahnow
19. Kara Durbin
20. Kasey Curtis
21. Kelly Xu
22. Laxman Subedi
23. Leslie Almond
24. Lorin Molander
25. Lorna Luebbe
26. Marc Alberts
27. Michele Kvam
28. Michelle Wildie
29. Niecie Weatherby
30. Phillip Popoff
31. Ping Liu
32. Renchang Dai
33. Ryan Frazier
34. Sachi Begur
35. Sara Leverette
36. Sheri Maynard
37. Stephanie Imamovic
38. Thor Angle
39. Tyler Tobin
40. Villamor Gamponia
41. Wendy Gerlitz

Consultant Staff (alphabetical by first name)

1. Claire Wendle
2. Sophie Glass
3. Will Henderson