EXH. KKD-4
DOCKET UE-210795
PSE'S CEIP
WITNESS: KARA K. DURBIN

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

In the Matter of **PUGET SOUND ENERGY** **Clean Energy Implementation Plan Pursuant to WAC 480-100-640**	**Docket UE-210795**

THIRD EXHIBIT (NONCONFIDENTIAL) TO THE PREFILED DIRECT TESTIMONY OF

KARA K. DURBIN

ON BEHALF OF PUGET SOUND ENERGY

JULY 11, 2022

PSE RESPONSE TO PUBLIC COMMENTS ON ELCC CALCULATIONS AND USE

Prepared pursuant to Order #1 in WUTC Docket UE-210220

December 3, 2021

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Appendices

1. Introduction and background

Puget Sound Energy ("PSE") filed a draft All-Source RFP on April 1, 2021 to meet capacity and clean energy resource needs established in the 2021 Integrated Resource Plan ("IRP"). PSE later filed revisions to the draft All-Source RFP on June 1 and June 8, 2021 to account for stakeholder comments and feedback from Washington Utilities and Transportation Commission ("WUTC" or "Commission") staff. Among the changes to its draft All-Source RFP, PSE added to its schedule two technical workshops for stakeholders to be held in summer 2021: (i) to discuss PSE's effective load carrying capability ("ELCC")[1] methodology and assumptions ("ELCC Workshop"), and (ii) to discuss the analysis of its proposed market reliance reduction ("Market Reliance Workshop"). Following an open meeting on June 11 at which the draft was discussed, the Commission approved the All-Source RFP with the following conditions in Order 1 in Docket UE-210220 on June 14, 2021:

1) PSE must post workshop materials to its RFP website at least seven calendar days prior to each workshop and that materials for the ELCC Workshop must include an ELCC review and primer;

2) PSE must circulate any Commission notices filed to this docket via the Company's website and email list; and

3) PSE must file a response to comments filed pursuant to the above-referenced notice within six weeks of the notice's deadline. If PSE agrees that a revision of the ELCC methodology or implementation in Phase 2 is warranted, PSE must file said revisions with the Commission and notify the Commission of the change in Phase 2 implementation.

PSE issued the final All-Source RFP to bidders on June 30 with a due date for bids of September 1, 2021. Additional information about the 2021 All-Source RFP can be found on PSE's RFP web site (www.pse.com/rfp).

Since issuing the All-Source RFP, PSE has hosted both workshops. The ELCC Workshop was held on August 31, 2021 and the Market Reliance Workshop was held on September 30, 2021. As directed in condition 1 of Order 1, PSE posted the workshop materials to its website seven calendar days prior to each workshop and provided an ELCC primer with the posted materials. As an added step, PSE also filed the ELCC Workshop materials in Docket UE-210220 on August 25,

[1] The effective load carrying capability ("ELCC") of a resource represents an estimate of its expected contribution toward meeting PSE's capacity need. As part of its integrated resource planning process, PSE calculates generic ELCCs based on the location and characteristics of a variety of generic resource types. PSE's RFP process utilizes both the generic ELCCs (in Phase 1) and resource-specific ELCCs (in Phase 2) in its evaluation of proposals.

2021. PSE also sent several email notifications to its RFP distribution list[2] regarding registration opportunities for the workshops and related posted materials.

In an effort to provide greater transparency and to ensure that PSE's methodology for calculating ELCC values is rigorous and accurate, PSE hired consultant, Energy and Environmental Economics, Inc. ("E3"), to review its methodology for reasonableness and provide recommendations for improvements. E3 presented its initial findings and recommendations at the ELCC Workshop on August 31 and thereafter produced a final report, which was posted to PSE's RFP web site (www.pse.com/rfp) upon completion on October 8. The report provides information about E3's experience estimating ELCC values and the scope of the review performed for PSE, and details their findings and recommendations.

On August 31, 2021, the Commission issued a notice of opportunity to file written comments on topics related to PSE's ELCC estimates and their use in ranking and bid evaluation for the All-Source RFP. Written comments were originally due by September 30; however, the Commission later extended this deadline to receive comments to October 22 at PSE's request to allow stakeholders an opportunity to review the report produced by E3 prior to submitting comments. As a result, PSE's deadline to file a response to the public comments was also extended to December 3, 2021. As directed in condition 2 of Order 1, PSE posted the Commission's notices on its RFP web site and sent email notifications to its RFP distribution list.

Thirteen unique sets of comments were filed in Docket UE-210220 by the October 22 due date.[3] Commenters included the Columbia River Inter-Tribal Fish Commission; James Adcock; JSR Capital, Inc.; Northwest & Intermountain Power Producers Coalition ("NIPPC"); Plus Power; Public Counsel in the Attorney General's Office; the Renewable Energy Group representing the Gray's Harbor Facility (biodiesel); Rye Development on behalf of the Swan Lake and Goldendale pumped storage hydro projects; and Thomas Dechert. Additionally, joint comments were filed on behalf of Renewable Northwest, the Northwest Energy Coalition and Rye Development; and a separate set of joint comments were filed on behalf of the Washington Clean Energy Coalition, Sierra Club and 13 other environmental advocacy groups.[4]

[2] PSE's RFP distribution list is a voluntary opt-in email distribution list that currently contains more than 800 contacts interested in both the All-Source and Demand Response RFPs (see Docket UE-210878). Contacts include many of the advocacy groups and individuals who participate in the integrated resource planning and clean energy advisory group processes, media outlets, potential RFP bidders, and other interested parties. To request to be added to the RFP distribution list, contact the AllSourceRFPmailbox@pse.com.

[3] JSR Capital, Inc. revised its comments twice during the comment period, resulting in a total of 15 sets of comments filed in Docket UE-210220, but only 13 sets of unique comments. JSR Capital filed a final set of comments on October 25, 2021.

[4] Advocacy groups cosigning the joint letter with Washington Clean Energy Coalition and Sierra Club include 350 Seattle, 350 Everett, 350 West Sound Climate Action, 350 Eastside, 350 Tacoma, Kitsap Environmental Coalition, Thurston Climate Action Team, Vashon Climate Action Group, Climate Action Bainbridge, Washington Physicians for Social Responsibility, the coalition of 14 People for Climate Action city groups in King County, East Shore Unitarian Church or Bellevue's Earth & Climate Action Ministry Team, and the Western Grid Group.

SECTION 1. INTRODUCTION AND BACKGROUND

This report is being filed pursuant to condition 3 of Order 1 as a response to public comments regarding the calculation and use of PSE's ELCC values, and the recommendations of E3. Section 2 below presents E3's summary findings and recommendations. Since many of the stakeholder comments touched on the same themes and supported the recommendations of E3, PSE has provided a response to each recommendation, including follow-up actions and the expected timing of such actions, and identified the entities that supported such recommendations. Section 3 summarizes and groups comments by topic that were not addressed in E3's recommendations and provides a response to each comment.

Appendix A is a complete copy of the final report produced by E3 detailing its findings and recommendations related to PSE's ELCC methodology and assumptions.

Finally, Appendix B offers an excerpt of the key points and recommendations made by each commenting entity. PSE has not modified the comments and recommendations in Appendix B, other than to excerpt them for the index and to indicate with footnotes where certain referenced tables and figures may be found. It should be noted that the index does not include the complete narrative filed by each commenting party. The filed comments of each party are available for review in their original format on the Commission's website in Docket UE-210220.

PSE would like to take this opportunity to thank everyone who participated in our summer workshops to discuss the company's ELCC methodology and market reliance reduction analysis. We would also like to thank all those who provided comments on the company's ELCC calculations and use. PSE appreciates all of the thoughtful feedback and engagement it has received on these topics. PSE hopes the discussions and the comment responses included in this report will be helpful in better understanding the company's ELCC methodology and next steps and PSE's market reliance reduction analysis.

2. E3 recommendations and related public comments

E3 summary findings

As described in Section 1, E3 produced a final report of its findings and recommendations, which is attached as Appendix B and can also be found on PSE's RFP web site (www.pse.com/rfp) in the 2021 RFP Bidders' Conference and Stakeholder Workshops section. In summary, E3's report found the following:[5]

> E3 finds that PSE's general approach to ELCC calculation is reasonable. While PSE's treatment of Mid-C does disadvantage battery storage ELCCs, there is no industry standard for how to address the issue of external market equilibrium, and whether it is appropriate to assume an adequate regional system is a real and difficult question. Beyond the question of how to treat the external market, the other topic requiring immediate attention in the current RFP process is the presentation of generic battery storage operating characteristics, which does not require changes in PSE's ELCC calculation methodology. While it would be ideal to address the treatment of Contingency Reserves and PSE's participation in the NWPP Reserve Sharing Program under its battery storage scenarios, this may require continued analysis beyond what is feasible within the current RFP timeline. Moving forward, PSE's treatment of resource correlations, temperature data, and hydropower operations merit additional analysis and potential adjustments, but without additional analysis it is unclear if changes in the treatment of these topics will produce significant changes in battery storage ELCCs; in the case of hydropower operations, updates to the PSE modeling approach could produce a reduction in battery storage ELCCs.

E3's report further noted that "even in the context of the recommendations [below], battery storage ELCCs are likely to be relatively low in a hydropower-dependent region like the PNW compared to other regions," but recommended the steps below to confirm this judgment.

Because many of the public comments filed in Docket UE-210220 addressed topics covered by E3's recommendations, and many of the public comments supported the recommendations, PSE has provided a response to each recommendation below, including next steps and associated timing. PSE has also identified the commenters who referenced and supported these recommendations in their comments.

[5] Energy and Environmental Economics, Inc. ("E3"), Review of Puget Sound Energy Effective Load Carrying Capability Methodology (October 2021), p. 3, http://www.pse.com/rfp.

SECTION 2. E3 RECOMMENDATIONS AND RELATED PUBLIC COMMENTS

E3 recommendations for PSE

E3 recommended implementing the following three steps before conducting the portfolio analysis in the RFP.

1) ***Conduct an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% Loss of Load Probability ("LOLP") standard before recalculating ELCC***

   PSE received six sets of comments supporting this recommendation. Supporting parties include: Public Counsel; James Adcock; Plus Power; joint comments from the Northwest Energy Coalition, Renewable Northwest and Rye Development, and joint comments from the Washington Clean Energy Coalition, Sierra Club and 13 other environmental advocacy groups.

   Consistent with E3's report, typical industry practice assumes that a utility will tune its own system to a specific reliability standard before calculating ELCCs but will not necessarily also tune the external market. The treatment of the external markets varies across the industry, ranging from excluding the market entirely to making simplified assumptions such as a fixed shape based on import limits. Nevertheless, before conducting the portfolio analysis in the RFP PSE will run an additional sensitivity of a GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP standard. Subsequently, PSE's resource adequacy model will then recalculate the peak capacity need and the supporting ELCC for this sensitivity to see how the results differ from the base assumption.

   Additionally, the NWEC, Renewable NW and Rye Development joint comments state the following:

   > We also note that there are some inconsistencies in E3's report related to their review of the impact of potential additions to the regional capacity by replacing 500 MW of perfect capacity with 500 MW of Mid-C capacity. A close review of Figures 2 and 3 reveal inconsistencies in the reported unserved energy in the plots and inconsistencies between the data in the plots and their textual interpretation. Without additional clarification, it is difficult to discern whether E3's analysis adequately investigates the potential sensitivity of PSE's modeling to Mid-C availability and reiterates the importance of PSE conducting additional analysis on this topic.

   The figures referenced above are based on a simple, back-of-the envelope example that E3 used to demonstrate how results might change if certain assumptions change in PSE's analysis. During the ELCC workshop, E3 clarified that this example was provided to illustrate why E3 is recommending an additional GENESYS run to obtain actual data, and not as a replacement for that analysis. As noted above, PSE will run an additional sensitivity of a GENESYS model run as recommended.

2) ***Restate ELCC values for battery storage in a manner more aligned with industry standards, such that storage can discharge at maximum capacity for X hours if the storage is defined as having X hours of duration, and align the presentation of ELCC values with the characterization of minimum, maximum, and nameplate MW values in RFP documentation***

   PSE received four sets of comments supporting this recommendation from the following parties: Public Counsel; James Adcock; Plus Power, and joint comments from the Northwest Energy Coalition, Renewable Northwest and Rye Development.

   PSE will run resource-specific ELCCs for Phase 2 of the RFP and will also update its generic resource assumptions for the 2023 Electric IRP progress report using the most up-to-date information.

3) ***Re-calculate battery storage ELCCs under the assumption that PSE's treatment of its own Contingency Reserves and the NWPP's Reserve Sharing Program is the same as in PSE's Base Case without battery storage, and investigate the significance of the revised results***

   PSE received two sets of comments supporting this recommendation from the following parties: Public Counsel and James Adcock.

   For the first hour of an event, PSE currently assumes that the NWPP reserve sharing will be available, and the event starts in hour two. However, E3's review demonstrated some inconsistency in how this was being applied in the model. To correct this, PSE will review the code and assumptions to ensure that assumptions are being correctly applied for Phase 2 of the RFP and the 2023 Electric IRP progress report.

E3 recommended implementing the following three steps in future IRP cycles:

4) ***Utilize weather-matched load that is aligned with wind and solar data***

   PSE received four sets of comments supporting this recommendation from the following parties: Public Counsel, James Adcock, JSR Capital and NIPPC.

   E3 is suggesting that PSE use the same weather year that corresponds to the wind speed and solar irradiance year. PSE will follow-up with E3 for ideas on how to adjust correlations as we begin building on the Northwest Power and Conservation Council's climate change data. Depending on the complexity of this methodology change, PSE will determine if the approach is reasonable for future IRP cycles.

5) ***Reevaluate its current approach to considering temperatures in developing load shapes based on (1) the use of two different weather stations, and (2) the changing climate***

PSE received six sets of comments supporting this recommendation and, in particular, the use of more current weather data that takes into account the changing climate from the following parties: Public Counsel; James Adcock; JSR Capital; NIPPC; joint comments from the Northwest Energy Coalition, Renewable Northwest and Rye Development; and joint comments from the Washington Clean Energy Coalition, Sierra Club and 13 other environmental advocacy groups.

PSE is currently developing a climate change update, which will be used for Phase 2 of the RFP and included in the 2023 Electric IRP progress report. This work will build on the Northwest Power and Conservation Council's climate change data used in its recent resource adequacy work.

6) ***Update modeling to incorporate hydro dispatch capabilities and hydro energy limitations.***

PSE received two sets of comments supporting this recommendation from the following parties: Public Counsel and James Adcock.

The current model takes daily hydro data for each of the 80 hydro years that corresponds to GENESYS. E3 suggested incorporating dispatch into the model to reflect how the hydro can be moved to balance load by hour. This will give more flexibility to the hydro and most likely lower the ELCC to storage. As E3 recognizes, modeling hydro as flexible is highly complex, because the flexibility depends on water conditions, operational constraints, and other factors that are difficult to quantify in a planning model. Additionally, this modeling approach will require PSE to move the model out of Python to a production cost model such as Plexos. Given the lead time needed to build a new resource adequacy model and the uncertainty around the NWPP Resource Adequacy program, it will not be feasible to incorporate this recommendation for Phase 2 of the RFP or the 2023 Electric IRP progress report. Therefore, consistent with E3's recommendation, PSE will explore this recommendation in future IRP cycles.

3. Additional public comments

Comments on PSE's ELCC methodology and use

In addition to comments consistent with the E3 recommendations, PSE also received comments from stakeholders on a variety of other related topics. PSE has summarized the comments below. See Appendix B for a more detailed index of comments from interested persons in their own words. Also see Docket UE-210220 for complete comments as filed.

1) ***Changing system needs: summer versus winter peaks – Several sets of comments pointed out that while PSE is currently a winter peaking utility, given climate change and shifting customer energy use patterns, it may in the future become a summer or dual-peaking utility. PSE's analysis and assumptions should reflect these changes. Additionally, some parties suggested that ELCC values in PSE's analysis should be differentiated between summer and winter to account for the potential seasonal load changes.***

   PSE received three sets of comments on this topic from the following parties: James Adcock, JSR Capital, and NIPPC.

   Depending on the complexity to re-code the model for this methodology change, PSE will determine if the approach is reasonable for future IRP cycles. To incorporate this change PSE will isolate a summer and a winter peak need and provide the corresponding ELCC values.

2) ***PSE's modeling methods do not properly account for the risk of an intense heat wave event that occurs during a low hydro year. The correlation of heat and drought may be stronger than random sampling of historical data might indicate. For example, a hot year could melt snowpack early, increase evaporation, and force reductions in hydropower. Constraints on hydropower plants could occur at the same time that customer loads increase due to more prevalent air conditioning.***

   Further, if hydropower is reduced on a regional basis, market prices for electricity will rise. To keep prices in check, PSE will want to maximize use of its gas and wind resources. However, wind energy may also decline during a heat wave, leading to a greater reliance on gas. PSE appears not to model a possible correlation between extreme heat and lower wind speed.

   Comment from: Joint comments from Washington Clean Energy Coalition, Sierra Club and 13 other environmental advocate groups

PSE recognizes the modeling constraint related to an intense heat wave event, and PSE is currently working on a climate change update, which will be used for Phase 2 of the RFP and the 2023 Electric IRP progress report. The assessment that a high heat and low hydro event can cause a loss of load event is correct. Low hydro events are also heavily correlated to reduced market availability, which is the basis for PSE's ongoing assessment of the reduction in market reliance. During these events, hydro is reduced, which also reduces market availability and can lead to lower ELCC values for energy storage resources that rely on the availability of the market for charging.

3) ***ELCC values from PSE's temperature sensitivity for some solar resources in 2031 are more than ten times larger in 2031 than the base scenario for those same resources. ELCC values from PSE's temperature sensitivity for solar-plus-storage and stand-alone storage resources in 2031 are two to three times larger in 2031 than the base scenario for those resources.***

    a) ***PSE should propose and adopt an alternative base value for the solar, solar-plus-storage, and stand-alone storage resources.***

    b) ***PSE should use the ELCC values for solar, solar-plus-storage, and stand-alone storage resources calculated by its consultant, Itron, in November 2020 as the baseline ELCC values rather than solely for a sensitivity analysis.***

Comment from NIPPC.

In the 2021 IRP, PSE evaluated temperature variations that increased the summer loss of load events. This temperature sensitivity is one model of possible weather changes and provides a preliminary view of a possible impact of warming temperatures as a result of climate change. The lessons from this sensitivity are useful as PSE plans for future resource adequacy analyses, but limited conclusions can be made to inform the preferred portfolio.

PSE will reassess ELCC using climate change weather data for Phase 2 of the RFP and for the 2023 Electric IRP progress report.

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4) ***The notion that whenever PSE has a shortfall it will occur continuously for multiple days at a time is false. Almost always there will be "off peak" hours during which PSE can recharge batteries, and almost always peak conditions are going to last four hours or less, in which case four-hour batteries can make a meaningful contribution to peak shaving and valley filling.***

Comment from James Adcock.

PSE disagrees with this assessment. Extreme weather events usually last for multiple days. If market power is unavailable due to low hydro or other conditions occurring in the rest of the region, there is no available energy to charge the battery.

5) ***In its August 19, 2021 response to a joint letter from Northwest Energy Coalition, Renewable Northwest and Rye Development (submitted on July 14, 2021), PSE stated:***

> ***There could be simulations in the RAM where the region has adequate supply (meaning the 1500 MW of transmission to short-term market imports are full), but PSE's system is short during some hours. Remotely-located energy storage systems could be charged during those hours, even though PSE's system is short. Hours when there are shortages in the region would impair the ability to charge these remote storage resources, not shortages on PSE's system. These are issues PSE will be exploring further in our analysis at the upcoming Resource Adequacy ("RA") workshop on August 31. Additionally, the RA workshop will include analysis performed by a third-party consultant that was hired by PSE working through PSE's Independent Evaluator.***

PSE should clarify:

a) ***when parties in this proceeding will see simulation updates for remotely-located storage resources;***

b) ***how these updates will be used in evaluating the 2021 RFP bids; and***

c) ***whether and when these new simulations will create a window for RFP respondents to amend pieces of their already-submitted proposals, something the commenter strongly supports.***

Comments from: Rye Development

To incorporate this change into the model, PSE will need to differentiate between on-system versus off-system energy storage resources. Depending on the complexity of this methodology change, PSE will work to determine if this model change can be reasonably incorporated for phase 2 of the RFP, or if the updates should be considered for future IRP cycles. If the change is not unduly burdensome, PSE will incorporate the updates.

7) ***During the ELCC workshop presentation, PSE stated that it calculates a last-in ELCC for energy storage by adding energy storage after perfect capacity. However, PSE has not clarified whether the energy storage dispatch algorithm can see and access energy from the added perfect capacity resource for the purposes of storage charging. If energy storage resources do not have access to the energy delivered by the perfect capacity resource for charging, then the perfect capacity added has no effect on the storage ELCCs, further degrading their value, and should be remedied. Please clarify.***

Comment from: Joint comments from Northwest Energy Coalition, Renewable Northwest and Rye Development

PSE will review the code and check the output of the model to confirm that the perfect capacity resource added is available for charging energy storage. If it is not, then PSE will correct the model for Phase 2 of the RFP and the 2023 Electric IRP progress report.

8) ***While the ELCC value of a particular resource is unique to each utility and it would be impossible to directly compare the BESS ELCC values of Portland General Electric ("PGE") and PSE, it is unclear how utilities with similar seasonal load profiles assess standalone energy storage resources so differently. PSE should:***

    a) ***Describe the manner in which a higher ELCC value would be assigned and quantified to energy storage located in a load pocket, consistent with the discussion of the value of such resources on page 29 of PSE's ELCC Workshop Presentation.***

    b) ***Provide greater transparency into the main drivers and assumptions for PSE's 24.8% ELCC for 4-hour storage, and clarify where PSE's model diverges from PGE's result of 60.0 – 85.0% ELCC for the same 4-hour duration asset class.***

    c) ***Clarify for stakeholders why PSE's 2021 IRP ELCC value for BESS significantly diverges from the 2017 IRP, which assigned an 88% ELCC for a 4-hour Li-ion storage facility.***

Comments from Plus Power.

The ELCC of a resource represents the peak capacity credit assigned to that resource. It is calculated in the resource adequacy model since this value is highly dependent on the load characteristics and the mix of portfolio resources. The ELCC of a resource is therefore unique to each utility. Since the ELCC is unique to each utility and dependent on load shapes and supply availability, it is hard to compare PSE's ELCC numbers with other entities. Some ELCCs are higher and some are lower, depending on PSE's needs, demand shapes and availability of the supply-side resources.

With respect to PSE and Portland General Electric ("PGE"), the two utilities have different electric supply portfolios. Additionally, the utilities have seasonal load profiles that are not necessarily comparable due to differences in customer class mix and weather patterns.

Of PSE's overall energy sales in 2020, 55 percent were to the residential customer class, 40 percent to commercial, and 5 percent to industrial (PSE 10-K 2020). PGE's overall 2020 energy sales were 40 percent residential, 35 percent commercial, and 25 percent industrial (PGE Annual Report 2020). PGE has a much larger industrial class than PSE, and PSE serves more energy to the residential class than PGE. Load patterns among customer classes can vary greatly.

Table 1. ***Energy sales by customer class for PGE and PSE***

	PGE	PSE
Residential	40%	55%
Commercial	35%	40%
Industrial	25%	5%

Weather patterns at PSE's Seattle-Tacoma Airport (centrally located in PSE's service area) are different from Portland General Electric's weather. Seattle is typically colder than Portland in the winter, and Portland is typically warmer than Seattle in the summer. Portland's milder winter and hotter summer contributes to Portland's dual-peaking characteristics.

Table 2. ***PGE and PSE heating and cooling degree days***[6]

(Base 65, 2020)

	PGE	PSE
HDD	3,836	4,122
CDD	600	332

[6] *Sources: PGE degree day ("DD") data comes from PGE's 2020 Annual Report. PSE's DD data comes from SeaTac data, which is available online at https://www.weather.gov/wrh/climate?wfo=sew.*

The loads profiles, varying weather conditions and different ELCC methodologies of each utility makes it difficult to compare the ELCC values of PGE and PSE at a high level.

PSE will run resource-specific ELCCs for Phase 2 of the All-Source RFP and update generic resource assumptions for the 2023 Electric IRP progress report using the most up-to-date information.

9) ***Importance of wind location diversity – PSE should not assume that wind generation farms are perfectly correlated to (or built exactly on top of) existing PSE wind. If PSE has a generating shortfall and the wind is blowing at a particular wind farm location and PSE assumes the addition of new wind at that same location, then the addition of new wind will not make a meaningful contribution to peak capacity because PSE already has generation at that location to meet the need.***

   Comment from James Adcock.

   PSE agrees that modeling wind location diversity is important, and the analysis PSE presented does not assume all wind is built exactly on top of existing PSE wind. PSE evaluated five unique generic wind locations in the 2021 IRP and accounted for the benefits of diversity to the portfolio. To maximize wind location diversity, PSE will run resource-specific ELCCs for Phase 2 of the RFP based on specific locations.

10) ***PSE should explain why it assigned a 60.5% ELCC value to the Golden Hills Wind Farm for the 2027 planning period. This wind farm is not in operation and will be delivered to PSE's system via firm transmission from the BPA John Day substation in Oregon, east of the Cascade Mountains. This seems counterintuitive to page 17 of the Resource Adequacy and ELCC primer (on page 17) where PSE notes that VERs are non-firm resources that cannot guarantee firm supply during peaking events, and thus will not be granted any capacity credit (referring to Mid-C delivered resources). PSE further adds that cold-weather and summer events in recent years took place where 5 MW and 61 MW, respectively, out of an 800 MW portfolio of wind resources was deliverable to load or operating. This treatment of a VERs resource seems inconsistent with treatment of a dispatchable storage resource within a local load pocket.***

   Comment from Plus Power.

   On page 17 of the Resource Adequacy and ELCC primer, PSE is referring to VERs delivering to Mid-C that are not shaped. The discussion on page 17 does not apply to Golden Hills for two reasons. First, Golden Hills is a shaped wind product, meaning that during winter peak hours Avangrid has guaranteed firm energy delivery. As page 17 notes, "VERs with an ability to shape supply will receive a capacity credit." And second, Golden Hills does not deliver to Mid-C, but instead delivers directly to PSE's system.

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11) On page 17 of the Resource Adequacy and ELCC primer, PSE is specifically referring to VERs delivering to Mid-C that are not shaped. The discussion on page 17 does not apply to Golden Hills for two reasons. First, Golden Hills is a shaped wind product, meaning that during winter peak hours Avangrid has guaranteed firm energy delivery. As page 17 notes, "VERs with an ability to shape supply will receive a capacity credit." Second, Golden Hills delivers directly to PSE's system and not to the Mid-C. For Phase 1 of the All-Source RFP, PSE is using the generic ELCC assumptions from the 2021 IRP to screen resources. PSE has stated that generic ELCC assumptions do not need to be updated for Phase 1 because in this phase resource comparisons will only be made between technologically similar resources. PSE should:

a) Provide additional transparency into how methodological updates affect storage ELCCs and whether the generic storage ELCCs from the IRP represent reasonable proxy values for a wide range of potential storage configurations with different round-trip losses, minimum and maximum storage levels, and other key parameters.

b) Demonstrate that screenings made in Phase 1 are robust to any implemented ELCC methodological updates in Phase 2. In the event that ELCC methodological updates materially affect the performance of any storage resource screened out in Phase 1 such that it could reasonably compete with resources (of any technological type) in Phase 2, then that storage resource should be advanced to Phase 2 for full evaluation.

Comments from: Joint comments from Northwest Energy Coalition, Renewable Northwest and Rye Development.

a) PSE acknowledges that there is a wide range of potential storage configurations with different round-trip losses, minimum and maximum storage levels, technology types and other key parameters. The 2021 IRP considered three different technology types (lithium-ion, flow, and pumped storage hydro) and four duration levels (2 hours, 4 hours, 6 hours, and 8 hours). PSE looked at the most common configurations of energy storage to represent the majority of these resources, with the understanding that not all specific configurations are represented. PSE will run resource-specific ELCCs for Phase 2 of the RFP and will also update its generic resource cost assumptions for the 2023 Electric IRP progress report using the most up-to-date information.

a) The best performing resources by technology category will advance to Phase 2 of the RFP. Since the bids will be grouped by technology and competing against similar bids, and PSE intends to advance sufficient resources by technology category to account for any potential shifts in the relative competitiveness of resources from updates to the ELCCs, it is unlikely that a particular resource category would be under represented in Phase 2. However, PSE is not precluded from adding more Phase 1 resources to the Phase 2 analysis, if necessary.

Other comments

PSE notes that in addition to comments related to the ELCC calculations and use, a number of interested persons also filed other comments. For example, Renewable Energy Group filed comments supporting biodiesel powered generation and noting that PSE’s analysis “appears reasonable given the unique regional generation mix”. In addition to comments on PSE’s ELCC methodology and assumptions, Jim Adcock also included comments about the stakeholder engagement process, in which he expressed concerns about past process cycles and the level of PSE’s response to data requests from stakeholders.

Additionally, two parties did not submit comments on the ELCC methodology and assumptions contemplated in this comment process but did submit comments on other topics. Columbia River Inter-Tribal Fish Commission filed comments on a variety of topics related to the acquisition of resources, including: the need for adequate electricity supplies and reserves, reducing peak loads, time-of-use pricing, importance of energy efficiency, reduction of greenhouse gases, prioritization of distributed solar, adding wind and solar energy, siting renewable resources, and prioritizing Montana resources near existing transmission. Likewise, Tom Dechert filed comments advocating the cessation of rebate programs that encourage rate payers to install gas-fired furnaces or other appliances in homes and businesses.

PSE has reviewed these filed comments and thanks the parties for their feedback. Appendix B provides an excerpt of the key points and recommendations made by each commenting party in their own words. A complete copy of the filed comments of each party is available for review in its original format in Docket UE-210220.

4. Next steps

As discussed in Section 2 (above), E3 found that, "PSE's general approach to ELCC calculation is reasonable." E3 also proposed six recommendations for improvements. PSE will make best efforts to complete as much of the recommended work as possible. However, given that several of these recommendations will require a significant amount of time to gather the data, develop a process, update the model, and benchmark the results, not all of the recommendations can be completed for Phase 2 of the RFP and the 2023 Electric IRP progress report. Consistent with E3's assessment, recommendations requiring longer lead times will be evaluated for future IRP cycles.

PSE is committing to completing the following recommended updates for Phase 2 of the RFP and the 2023 Electric IRP progress report:

1. PSE will run an additional sensitivity of a GENESYS model run assuming regional capacity additions such that the region meets a 5 percent LOLP standard.
2. PSE will run resource-specific ELCCs for Phase 2 of the All-Source RFP and update generic resource assumptions for the 2023 Electric IRP progress report using the most up-to-date information.
3. PSE will review its modeling code and assumptions to ensure that assumptions are being correctly applied for the NWPP reserve sharing program.
4. PSE is currently developing a climate change update. This work will build on the Northwest Power and Conservation Council's climate change data, used in their recent resource adequacy work.

Additionally, PSE will evaluate the magnitude and complexity of the following recommendations. Due to the tight timeline for Phase 2 of the RFP and the 2023 Electric IRP progress report, some or all of these recommendations may need to be considered for future IRP cycles to allow adequate time for model preparation and quality review.

5. PSE will follow-up with E3 to explore different ways to approach correlations between wind/load and solar/load.
6. PSE will evaluate the modeling work associated with isolating a summer and a winter peak need, and the corresponding ELCC values.
7. PSE will evaluate the modeling work to update the model to differentiate between on-system vs. off-system energy storage resources.

5. Glossary

BESS	Battery energy storage systems
BPA	Bonneville Power Administration
CDD	Cooling degree day
DD	Degree day
Commission	Washington Utilities and Transportation Commission (see also "WUTC")
ELCC	Effective Load Carrying Capability, which represents an estimate of a resource's contribution toward meeting the capacity need of a utility
HDD	Heating degree day
IRP	Integrated Resource Plan
Mid-C	Mid-Columbia River trading hub
MW	Megawatts
NIPPC	Northwest & Intermountain Power Producers Coalition
NWEC	Northwest Energy Coalition
PGE	Portland General Electric
PSE	Puget Sound Energy
RA	Resource adequacy
RAM	Resource adequacy model

SECTION 5. GLOSSARY

RFP	Request for proposals
VERs	Variable energy resources
WAC	Washington Administrative Code
WUTC	Washington Utilities and Transportation Commission (see also the "Commission")

PUGET SOUND ENERGY

PSE Response to Public Comments on ELCC Calculations and Use:

Appendix A. Review of Puget Sound Energy Effective Load Carrying Capability Methodology, prepared by Energy and Environmental Economics, Inc. ("E3")

Review of Puget Sound Energy Effective Load Carrying Capability Methodology

October 2021

Energy+Environmental Economics

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Review of Puget Sound Energy Effective Load Carrying Capability Methodology

September 2021

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1 Introduction

1.1 Status of PSE's IRP and All-Source RFP

Puget Sound Energy's (PSE) most recent Integrated Resource Plan (IRP), filed in April 2021, indicated a need for new resources, to meet both peak capacity needs and compliance under the state of Washington's Clean Energy Transformation Act (CETA). In response to this, PSE filed a draft All-Source Request for Proposals (RFP) with the Washington Utilities and Transportation Commission (WUTC) that same month. This draft filing initiated a 45-day public comment period. In June 2021, the Commission approved the All-Source RFP. However, given stakeholder comments on the draft RFP regarding the effective load carrying capability (ELCC) for generic resources, especially battery storage resources, the WUTC required additional information on PSE's methodology for estimating effective load carrying capability (ELCC). Specifically, this included a primer on ELCC and a workshop on the subject in August 2021.

1.2 E3's Review and Scope of Work

To ensure that its ELCC calculations are rigorous and accurate, PSE retained Energy and Environmental Economics, Inc. (E3) through its Independent Evaluator, Bates White, to review PSE's methodology for calculating ELCC values, to provide an opinion on its reasonableness, and to recommend any necessary improvements. E3 has extensive experience with ELCC estimation across different jurisdictions and for different stakeholders, as well as resource adequacy analysis more broadly. In addition to direct ELCC modeling, E3 regularly delivers presentations and expert testimony on ELCC topics including background, application, and ELCC methodology.

E3 reviewed PSE's ELCC methodology and the results of their calculations, which required reviewing modeling methods and available documentation. The goal was to evaluate the reasonableness of PSE's calculations of ELCC for battery storage on its system. To do so, this review aimed to answer the following questions:

1) Does Puget Sound Energy (PSE) use industry-standard methodology for calculating ELCC?

2) Does PSE use reasonable input data in its ELCC modeling?

    a. Does PSE reflect the relevant correlations between data inputs?

    b. Does PSE appropriately capture regional dynamics in its calculation of ELCC?

3) Does PSE's ELCC calculation methodology appropriately capture the interactivity between intermittent and energy-limited resources?

In addition to the review above, E3 participated in PSE's August 2021 ELCC public workshop.

1.3 Summary of Findings

E3 finds that PSE's general approach to ELCC calculation is reasonable. While PSE's treatment of Mid-C does disadvantage battery storage ELCCs, there is no industry standard for how to address the issue of external market equilibrium, and whether it is appropriate to assume an adequate regional system is a real and difficult question. Beyond the question of how to treat the external market, the other topic requiring immediate attention in the current RFP process is the presentation of generic battery storage operating characteristics, which does not require changes in PSE's ELCC calculation methodology. While it would be ideal to address the treatment of Contingency Reserves and PSE's participation in the NWPP Reserve Sharing Program under its battery storage scenarios, this may require continued analysis beyond what is feasible within the current RFP timeline. Moving forward, PSE's treatment of resource correlations, temperature data, and hydropower operations merit additional analysis and potential adjustments, but without additional analysis it is unclear if changes in the treatment of these topics will produce significant changes in battery storage ELCCs; in the case of hydropower operations, updates to the PSE modeling approach could produce a reduction in battery storage ELCCs.

E3 recommends that PSE do the following before conducting the portfolio analysis in the RFP:

1) Conduct an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP standard before recalculating ELCC;

2) Restate ELCC values for battery storage in a manner more aligned with industry standards, such that storage can discharge at maximum capacity for X hours if the storage is defined as having X hours of duration, and align the presentation of ELCC values with the characterization of minimum, maximum, and nameplate MW values in RFP documentation; and

3) Re-calculate battery storage ELCCs under the assumption that PSE's treatment of its own Contingency Reserves and the NWPP's Reserve Sharing Program is the same as in PSE's Base Case without battery storage, and investigate the significance of the revised results.

E3 recommends that PSE do the following in future IRP cycles:

1) Utilize weather-matched load that is aligned with wind and solar data;

2) Reevaluate its current approach to considering temperatures in developing load shapes based on (1) the use of two different weather stations, and (2) the changing climate;

3) Update modeling to incorporate hydro dispatch capabilities and hydro energy limitations.

E3 expects that even in the context of the recommendations above, battery storage ELCCs are likely to be relatively low in a hydropower-dependent region like the PNW compared to other regions. To confirm this judgment, however, E3 recommends the additional steps above.

2 ELCC Background

2.1 Defining ELCC and Applications

First introduced as a concept in the 1960s, ELCC has gained popularity in recent years as a method to express the capacity contribution of intermittent and energy-limited resources in terms of equivalent "perfect" capacity (capacity that is always available). In this respect, ELCC is technology agnostic: a system with a given quantity of ELCC megawatts will achieve the same level of reliability, regardless of what types of resources are providing those megawatts. The more the construct of ELCC is applied across resources within a resource adequacy program, the more adequately prepared that program will be to accurately capture the effects of future portfolio changes, and the more level a playing field it will create for all resources that can contribute to resource adequacy needs.

The calculation of ELCC relies on sophisticated "loss-of-load-probability" modeling, which simulates the electricity system under many decades of different load and resource conditions. These models, which allow system planners to calculate the expected frequency, duration, and magnitude of reliability events on a system with a given portfolio of resources, can be used to compare the reliability contributions of different resources – including conventional thermal generation, hydro generation, and intermittent and energy-limited resources – to a perfect capacity resource. While ELCC calculations require rigor and complexity in their derivation, ELCC produces capacity value estimates that capture the most significant challenges that will arise with increased penetrations of renewables, storage, and other resources.

The ELCC of a resource depends on the following:

+ Coincidence of production with load – A positive correlation with load means higher capacity value.
+ Production variability – Statistically, the possibility of low production reduces the value of a resource.
+ Reliability target – Effective capacity has a non-linear relationship with system Loss-of-Load Expectation (LOLE), meaning that incremental additions of a given resource do not necessarily translate into constant improvements in reliability.
+ Existing quantity of other resources – The same or similar resource shapes have a diversity penalty, while complementary resource shapes have a diversity benefit.
+ Sustained peak – The ability to sustain output for longer durations.

Because of the interactions between resources in a portfolio, there is no single value that accurately captures the contribution of an individual resource toward the reliability of a portfolio under all circumstances. Instead, there are two types of ELCC values that can be uniquely defined and calculated, from which all practical applications of ELCC must be derived:

+ Portfolio ELCC: the combined capacity contribution of a portfolio of intermittent and energy-limited resources. Because all resources are evaluated together, this method inherently captures all interactive effects and combined capability of the resources. This method is most important for assessing system reliability.

- Marginal ELCC: the incremental capacity contribution of a specific resource (or combination of resources), measured relative to a specified portfolio. This method is most important for procurement and assessing how a new incremental resource will contribute to system capacity needs.

2.2 Importance of ELCC for Assessing Resource Adequacy

Historically, simple and practical heuristic methods have been used to assign capacity credits to individual intermittent or energy-limited resources. These simplifications have been adequate in many places due to the low penetration of renewables and energy storage. However, they do not appropriately capture the reliability dynamics of the system at higher penetrations when the need for accurate representation of their characteristics is most critical.

Specifically, resource adequacy programs across the US regularly employ ELCC for the following reasons:

- It captures how intermittent and energy-limited resources can interact to meet resource adequacy needs.
    - For example, the finite duration limits the ability of energy storage to meet demand across extended periods. This effect can be interpreted in multiple ways: either (1) the marginal ELCC of storage with a fixed duration will continue to decline as more is added to the system, or (2) storage with progressively increasing duration is needed to sustain a high capacity value.

- Its ability to highlight the diminishing marginal returns of a specific resource with increasing scale – that is, continuing to add more and more to an electricity system will produce lower and lower marginal resource adequacy benefits.
- ELCC on a portfolio level exposes synergistic and antagonistic interactions between different resources in a system. Synergistic means that different resources complement each other and, together, have a higher ELCC, than the sum of their parts. Conversely, an antagonistic relationship would produce the opposite effect.
- Its ability to "level the playing field" means the methodology can reasonably be used to compare drastically different capacity portfolios with the same ELCC.

2.3 ELCC Practices and Industry Standards

2.3.1 LACK OF SINGLE NATIONWIDE STANDARD FOR RESOURCE ADEQUACY

Many factors affect resource adequacy, including the characteristics of load (magnitude, seasonal patterns, weather sensitivity, hourly patterns) and resources (size, dispatchability, forced outage rates, and other limitations on availability). There is no unified standard or method for determining resource adequacy across the industry. Rather, each power system defines its own resource adequacy requirements, acting under oversight from state, provincial, or local authorities, based on a variety of factors including, in some cases, evaluations of the costs and benefits of achieving higher or lower reliability standards. If a power system's resources are inadequate to serve its load, North American Electric Reliability Council ("NERC") standards require it to proactively curtail service during a resource shortfall to protect against the possibility of an interconnection-wide reliability event.

Utilities use many metrics to quantify the frequency, magnitude, and duration of loss-of-load events. See Table 1 below for a summary of the reliability metrics. While there is no continent-wide requirement for resource adequacy, many power systems in North America are planned based on a standard of "1-day-in-10-years". This standard requires that there be sufficient generation and transmission resources to serve load during all but one day every ten years. It is frequently implemented as requiring a loss-of-load expectation ("LOLE") of 0.1 days per year. Because directly measuring the LOLE reliability of a system is data-intensive and computationally complex, loss-of-load studies are often used to define a planning reserve margin ("PRM"), measured as the quantity of capacity needed above the median year peak load to meet the LOLE standard, to serve as a simple and intuitive metric that can be utilized broadly in power system planning.

Table 1. Summary of Reliability Metrics[1]

Metric	Units	Description	Examples
Loss of Load Probability ("LOLP")	%	The probability of system demand exceeding the available generating capacity during a given time period	Northwest Power and Conservation Council: 5% loss of load probability
Loss of Load Events ("LOLEV")	Events/year	The average number of loss of load events per year, of any duration or magnitude, due to system demand exceeding available generating capacity	Most U.S. Systems: 1 loss-of-load event per decade, or 0.1 event per year. See below
Loss of Load Expectation ("LOLE")	Days/year	The average number of days per year with loss of load (at least once during the day) due to system demand exceeding available generating capacity	See below
Loss-of-Load Hours ("LOLH")	Hours/year	The average number of hours per year with loss of load due to system demand exceeding available generating capacity	See below
Normalized Expected Unserved Energy ("EUE")	MWh/year	The average total quantity of unserved energy (MWh) over a year due to system demand exceeding available generating capacity	See below

2.3.2 DIVERSITY OF ELCC PRACTICES AMONG UTILITIES

ELCC is a widely used metric throughout the United States. Due to its popular adoption in the 1960s, it has gained significant traction among utilities, utility commissions and Independent System Operators; however, many employ ELCC in different ways. Below are some examples of how ELCC has been implemented:

[1] NWPP 2019, "Exploring a Resource Adequacy Program for the Pacific Northwest" - https://www.nwpp.org/private-media/documents/2019.11.12_NWPP_RA_Assessment_Review_Final_10-23.2019.pdf.

- The California Public Utilities Commission uses marginal ELCC for RPS program bid ranking and selection, and average ELCC for the RA program;
- The Mid-Continent Independent System Operator (MISO) allocates system-wide ELCC as its capacity credit to ascertain reliability;
- The New York Independent System Operator (NYISO) uses ELCC to quantify the capacity contributions of limited duration resources like storage; and
- Many utilities use marginal ELCC for evaluating the capacity contribution of new resources, including PSE, Avista, Portland General Electric, NorthWestern Energy, NV Energy, Xcel Energy, El Paso Electric, Duke Energy, Southern Company, and others.

2.3.3 NORTHWEST POWER AND CONSERVATION COUNCIL RA COMMITTEE AND MODELING

Under its charter to ensure prudent management of the region's federal hydro system while balancing environmental and energy needs, the Northwest Power and Conservation Council ("NPCC"), with oversight from its Resource Adequacy Advisory Committee ("RAAC"), conducts regular assessments of the resource adequacy position for the portion of the Northwest region served by the Bonneville Power Administration (consisting of Washington, Oregon, Idaho and the portions of California, Nevada, Utah, and Montana that are in the Columbia River Basin).

In 2011, the NPCC established an informal reliability target for the region of 5% annual LOLP—a metric that determines the capacity needed for the region to experience reliability events in fewer than one in twenty years. The 5% LOLP is unique to the Northwest region and is not widely used throughout the rest of North America.

NPCC uses GENESYS, a stochastic LOLP model with a robust treatment of the region's variable hydroelectric conditions and capabilities, to examine whether regional resources are sufficient to meet this target on a five-year ahead basis. These studies count only existing resources, planned resources that are sited and licensed, and the energy efficiency savings targeted in the NPCC's power plan. The studies provide valuable information referenced by regulators and utilities throughout the region and are meant to be an early warning of potentially insufficient resource development. While the work of NPCC is widely regarded as the most complete regional assessment of resource adequacy for the larger region, ultimately each individual utility must conduct its own resource adequacy planning to determine its need for new capacity.

NPCC's resource adequacy modeling heavily influences PSE's resource adequacy modeling, and ultimately its ELCC analysis. Like the NPCC's own modeling, PSE aims to achieve a 5% LOLP and tunes its reliability model to this standard when beginning its ELCC analysis. It also uses GENESYS to help calculate the overall regional resource adequacy conditions; specifically, its starting point for the 2021 IRP modeling was the GENESYS model from the NPCC power supply adequacy assessment for 2023. That specific version of GENESYS conducts 7040 simulations that consist of permutations of 80 different years of hydro conditions and 88 years of temperature conditions. These 7040 simulations reflect the combinations of load and hydro resource conditions for each separate analysis that ultimately makes up the ELCC calculations.

3 PSE Approach

3.1 PSE Model

PSE uses three models for its ELCC analysis. The primary model is the Resource Adequacy Model (RAM), which uses 7040 individual simulations that consist of combinations of 80 historical hydro years of data and 88 temperature years of data, along with load data, resource operating data, and external market modeling for short-term market purchases. The results of the simulations allow for the calculation of reliability metrics (LOLP, LOLE, EUE, etc.), as well as the quantification of the need for reliability-driven capacity to reach reliability standards and ELCC calculations for intermittent and energy-limited resources. To estimate availability for short-term market purchases, two other models are used: GENESYS and the Wholesale Purchase Curtailment Model ("WPCM"). GENESYS (also described in the section above) is a model of the Pacific Northwest region and shapes regional hydro to minimize regional curtailments and fully utilize California imports. Using the outputs of the GENESYS model, WPCM is used to allocate those regional curtailments to the PSE system.

3.2 Input Data

E3 requested, received, and reviewed the following input data used by PSE for its ELCC calculations:

- 8760 profiles for load, solar, and wind, along with battery storage charging and discharging schedules;
- Nameplate capacity of thermal resources;
- Hydro availability data;
- Mid-C market availability estimates; and
- Generic battery storage operating characteristics.

3.3 Output Data

E3 requested, received, and reviewed the following outputs from PSE's ELCC modeling:

- Hourly energy production estimates by resource type (including the external Mid-C market and its components) and other components used to calculate hourly unserved energy and loss of load events;
- Reliability metric results (e.g., LOLP, EUE, LOLE);
- Outage duration and frequency results for January and February (the months with the most reliability events); and
- ELCC calculation results.

Model input and output data was reviewed for the years 2027 and 2031 in the PSE forecast, each representing 7040 combinations of 80 hydro years and 88 temperature years. While E3 did obtain data from PSE's Temperature Sensitivity case described in its 2021 IRP, E3's review and conclusions are focused on PSE's Base Case, since the ELCC results of this case are reflected in the current RFP.

4 Key Issues

4.1 General LOLP Approach

4.1.1 ISSUE DESCRIPTION

E3 investigated whether PSE's application of the LOLP standard in its resource adequacy modeling is appropriate, and whether its approach for estimating battery storage ELCCs as an extension of this approach is reasonable.

4.1.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

In alignment with the practice of other entities in the region, PSE tunes its system to meet a 5% LOLP standard, providing the starting point for evaluating the ELCCs of generic resources in future years. For storage and variable resources, an additional step is taken by adding storage capacity to a system that already meets the 5% LOLP standard and then removing perfect capacity until expected unserved energy (EUE) returns to its previous level that is equivalent to the 5% LOLP standard.

While LOLP is a common reliability metric in the Pacific Northwest region, LOLE is the most commonly used loss-of-load reliability metric throughout the industry and specifically a standard of 0.1 days of LOLE per year (see Table 2).

Table 2. Reliability Metrics in Various Jurisdictions[2]

Jurisdiction	Reliability Metric(s)	Standard Value	Notes
AESO	**EUE**	800 MWh/year (0.0014%)	AESO monitors capacity and can take action if modeled EUE exceeds threshold; 34% PRM achieved in 2017 w/o imports
Australia	**EUE**	0.002%	System operator monitors forecasted reliability and can intervene in market if necessary
CAISO	**PRM**	15%	Stipulated, not explicit.
ERCOT	**N/A**	N/A	Tracks PRM for information purposes. PRM of 13.75% achieves 0.1 events/yr.
Florida	**LOLE**	0.1 days/year	15% PRM required in addition to ensuring LOLE is met
Great Britain	**LOLH**	3 hours/year	5% (Target PRM 2021/22) 11.7% (Observed PRM 2018/19)
Ireland	**LOLH**	8 hours/year	LOLH determines total capacity requirement (10% PRM) which is used to determine total payments to generators (Net-CONE * PRM)
ISO-NE	**LOLE**	0.2/0.1/0.01 days/year	Multiple LOLE targets are used to establish demand curve for capacity market
MISO	**LOLE**	0.1 days/year	8.4% UCAP PRM; 17.1% ICAP PRM.
Nova Scotia	**LOLE**	0.1 days/year	20% PRM to meet 0.1 LOLE standard

[2] For additional examples and context, see: https://irp.nspower.ca/files/key-documents/presentations/20190807-02_-E3-Capacity-Study-Overview.pdf.

NYISO	**LOLE**	0.1 days/year	LOLE is used to set capacity market demand curve; Minimum Installed Reserve Margin (IRM) is 16.8%; Achieved IRM in 2019 is 27.0%
PacifiCorp	**N/A**	N/A	13% PRM selected by balancing cost and reliability; Meets 0.1 LOLE
PJM	**LOLE**	0.1 days/year	LOLE used to set target IRM (16%) which is used in capacity market demand curve
SPP	**LOLE**	0.1 days/year	PRM assigned to all LSEs to achieve LOLE target: 12% non-coincident PRM, 16% coincident PRM.

The NPCC has chosen LOLP as its reliability metric and has used it since 2011, driving its annual resource adequacy assessments in the region and influencing the decision of utilities in the region, including Avista, as well as the NPCC itself.[3] Further, in PSE's 2015 IRP, PSE modified its reliability standard to be driven by the value of loss-of-load to its customers. However, this resulted in an expression of concern from the WUTC, and led to a return to the use of a 5% LOLP reliability standard in PSE's 2017 IRP.

Unlike LOLE, LOLP does not account for event duration and the number of events in a year. This matters because LOLP does not effectively take generator characteristics like production time and duration into account when assessing system reliability. Sizing the system for LOLP reduces the chances of having a

[3] Avista's 2021 IRP notes that its Aurora capacity expansion "model must also meet a 5 percent LOLP threshold for reliability when selecting new resources." (Avista 2021 IRP, page 2-19. https://www.myavista.com/-/media/myavista/content-documents/about-us/our-company/irp-documents/2021-electric-irp-w-cover-updated.pdf.)
The Northwest Power and Conservation Council (NPCC) stated in its most recent power plan (2016) that "A specific year's power supply extracted from an RPM analysis is deemed to be acceptably adequate if its LOLP ranges between 2 and 5 percent." (NWPCC 2016, pg 11-4.
https://www.nwcouncil.org/sites/default/files/7thplanfinal_allchapters_1.pdf.)

single event but it does not necessarily minimize the event duration or magnitude. While LOLE does not account for the magnitude of the event (supply shortfall), it does seek to limit the duration and frequency of events in a year. Although a system may be designed to have a 5% probability of LOL occurrence, when an event does occur, it may be several hours long. Alternatively, LOLE, while possibly having a higher event probability than 5%, would produce a system with limited event durations.

4.1.3 E3 CONCLUSION

E3 finds that PSE's application of the LOLP standard in its resource adequacy modeling, and the 5% standard in particular, is appropriate for two reasons:

1) There is precedent in the region for this standard, with the NPCC's RAAC using it for the last decade to annually assess reliability in the region, as well as its use by other utilities in the region, and PSE's usage following feedback from the WUTC after its 2015 IRP. Given the complexity of LOLP analysis and ELCC calculations, E3 believes there is value in utilizing methodologies that are consistent over time, that are in keeping with common regional practices that stakeholders are familiar with, and that have precedence in application to regulatory proceedings in a given jurisdiction. PSE's current methods are consistent with how the utility has evaluated ELCCs in the past, are in keeping with and indeed explicitly linked to the regional analysis performed by the NPCC, are similar to the methodologies utilized by other utilities, are familiar to PSE stakeholders, and have been previously accepted for use by the WUTC.

2) The LOLE of the Base Case for the two years that were tested for ELCC (2027 and 2031) and were tuned to a 5% LOLP by adding reliability-driven perfect capacity is in the 0.10-0.12 days/year range, which is very close to the 0.1 standard discussed above. Given this, E3 would expect that tuning the system to 0.1 LOLE rather than 5% LOLP would result in very minimal changes to the portfolio, and hence to the resulting ELCC values.

4.2 Treatment of Mid-C Market Availability

4.2.1 ISSUE DESCRIPTION

E3 investigated how PSE's treatment of the availability of market purchases from the Mid-Columbia (Mid-C) trading hub impacts its ELCC calculations in general, and whether it disadvantages battery storage ELCCs in particular.

4.2.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

Utilities rely on a combination of self-owned generation, bilateral contracts, and front-office transactions (FOTs) to satisfy their resource adequacy requirements. FOTs represent short-term firm market purchases for physical power delivery. FOTs are contracted on a month-ahead, day-ahead, and hour-ahead basis. A survey of utility IRPs in the PNW reveals that most utilities expect to meet a significant portion of their peak capacity requirements by using FOTs.[4]

[4] For additional discussion, see: https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf.

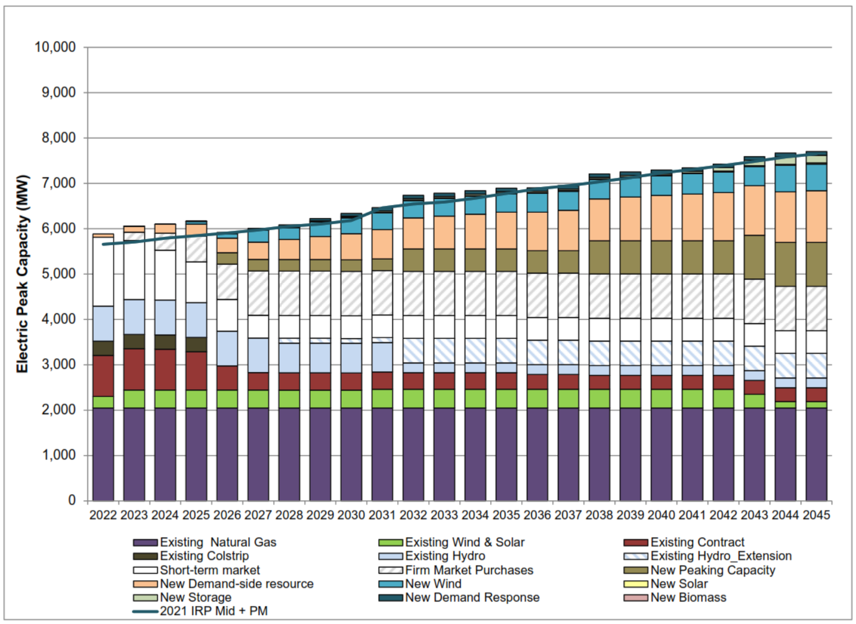
FOTs may be available to utilities for several potential reasons, including regional capacity surplus with some generators uncontracted to a specific utility or natural load diversity between utilities. The use of FOTs in place of designated firm resources can result in lower costs of providing electric service, as the cost of contracting with existing resources is generally lower than the cost of constructing new resources. However, as loads grow in the region and coal generation retires, the region's capacity surplus is shrinking, and questions are emerging about whether sufficient resources will be available for utilities to contract with for month-ahead and day-ahead capacity products. In a market with tight load-resource balance, extensive reliance on FOTs risks under-investment in the firm capacity resources needed for reliable service.

At the same time, failure to consider the availability of surplus energy in the regional market would result in over-procurement and higher costs for PSE ratepayers. It is reasonable for PSE to assume that some amount of energy would be available in the market due to the nature of the region's hydroelectric resource base, which produces surplus energy during most years. PSE must therefore strike a careful balance between the potential reliability implications and cost savings associated with reliance on the regional market.

Mid-C market interactions are an important consideration for PSE's system. As such, PSE includes "short-term wholesale (spot) market purchases up to PSE's available firm transmission import capability from the Mid-C" as an existing resource in reliability planning.[5] Referring to Figure 1, this is currently roughly a quarter of PSE's peak capacity.

Figure 1. PSE Preferred Portfolio Meeting Electric Peak Capacity[6]

Figure 3-6: Preferred Portfolio Meeting Electric Peak Capacity and Reducing Market Risk



In its ELCC modeling, PSE does not assume that reliability-driven (perfect) capacity additions are made to the broader Pacific Northwest region to achieve a reliability standard. Instead, given that PSE is testing future years 2027 and 2031, PSE assumes, based on NPCC GENESYS cases, that the regional system's reliability degrades below accepted resource adequacy thresholds as load continues to grow and plants retire. However, as mentioned in the section above, PSE adds

[5] PSE 2021 Final IRP, pg 7-11.
[6] PSE 2021 Final IRP.

reliability-driven capacity to bring its own system up to a 5% LOLP, with more local capacity added as the reliability of the external market degrades.

Mid-C market availability declines over time in PSE's modeling, resulting in increased forecasted curtailment from the Mid-C market for PSE's system. Fluctuations in energy from Mid-C are the largest contributor to outages in PSE's modeling and are the most frequent primary contributor (in MW) to longer duration outages (5+ hours). Table 3 below shows the frequency of outages of different lengths in January 2027 in the Base Case. These longer duration outages reduce the ELCC for the energy-limited battery storage resources.

Table 4 shows statistics for how the median capacity by resource type changes during hours with and without unserved energy and depending on the duration of the outage event.

Table 3. Summary of Outage Events by Duration in PSE Base Case – January 2027[7]

Frequency of loss of load event occurrences					
1 hour	1-2 hour	3-4 hour	5-6 hour	7-8 hour	9+ hour
131	95	155	72	31	82

[7] E3 analysis of PSE IRP data.

Table 4. Summary of Resource Performance During Outages in PSE Base Case – January 2027[8]

	Median MWh of Energy, by Outage Duration					
Resource	No Outages	All Outages	3-4 hr	5-6 hr	7-8 hrs	9+ hr
Contracts	740	747	747	747	747	740
Hydro	596	515	562	524	502	492
Load	3,344	5,371	5,554	5,375	5,322	5,182
Mid-C	1,415	370	1,307	495	380	190
Solar	0	0	0	0	3	1
Thermal	1,959	1,880	1,880	1,826	1,927	1,899

Given that load growth is assumed in the modeling of the Mid-C external market and no generic capacity is added, the reliability of the Mid-C degrades further between the two ELCC test years, 2027 and 2031. This may result in longer-duration reliability events on the PSE system, since availability of Mid-C imports is the key driver of these events. PSE does add more perfect capacity to its own system in 2031 (1,361 MW) than in 2027 (907 MW). This additional capacity reduces the frequency of loss-of-load events to bring the system up to a 5% LOLP standard, and increases battery storage ELCCs (see Table 5), however it does not change the shape of outages on the system because it is always available.

[8] E3 analysis of PSE IRP data.

Table 5. Peak Capacity Credit for Battery Storage in 2021 PSE IRP[9]

Figure 2-6: Peak Capacity Credit for Energy Storage

BATTERY STORAGE	Capacity (MW)	Peak Capacity Credit Year 2027	Peak Capacity Credit Year 2031
Lithium-ion, 2-hr, 82% RT efficiency	100	12.4%	15.8%
Lithium-ion, 4-hr, 87% RT efficiency	100	24.8%	29.8%
Flow, 4-hr, 73% RT efficiency	100	22.2%	27.4%
Flow, 6-hr, 73% RT efficiency	100	29.8%	35.6%
Pumped Storage, 8-hr, 80% RT efficiency	100	37.2%	43.8%

Typical industry practice assumes that a utility will tune its own system to a specific reliability standard before calculating ELCCs, but will not necessarily also tune the external market. The treatment of the external markets varies across the industry ranging from excluding the market entirely to making simplified assumptions such as a fixed shape based on import limits. For example, Duke Energy has applied a modeling framework that models imports as a dynamic resource on an hourly basis, driven by the estimated relationship between net load and market purchases.[10] By contrast, the California Public Utility Commission (CPUC) assumes a fixed constraint on imports, with an additional constraint applied only during hours where gross electric demand exceeds the 95th percentile.[11] Similarly, the Public Service Company of New Mexico assumes a constant constraint that 50 MW of market purchases will be available during its

[9] PSE Final 2021 IRP, pg 2-13.
[10] See page 19-20: https://dms.psc.sc.gov/Attachments/Matter/41d424e5-077b-4ff9-8bb3-3c31467b2638.
[11] See pages 22-23: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772681.PDF.

net peak period.[12] PSE is including the external market but is modeling it as a dynamic resource accounting for hydro energy, outages and other competing transmission needs.

Because the Mid-C market is modeled as a dynamic resource with varied output and outages, a less reliable Mid-C market may result in more long duration events with low import availability, reducing battery storage ELCCs. However, there is no single industry standard for how to address unreliable external markets. Excluding the market altogether is not realistic for PSE. Conversely, determining whether it is appropriate to add reliability-driven capacity to the external market before beginning ELCC calculations is a real and difficult question and has real world implications. PSE does not have control over the reliability of the external system, and how much they would have to contribute to achieve a reliable broader PNW system is an open question. Further, if reliability-driven capacity were added to the Mid-C market that would likely result in less reliability-driven capacity needed for the PSE system. The ultimate impact on storage ELCC calculations cannot be known without further modeling.

To illustrate the impact of potential additions to regional capacity, E3 generated the dispatch plots below from the week of January 25, 2027 in the PSE Base Case. This week was chosen because of a 42-hour outage that occurs in draw 1687 (out of 7040), representing the combination of hydro calendar year 1947 (in which streamflow was the lowest of all 80 hydro years) and temperature calendar year 1943. In Figure 2, PSE's modeled dispatch is shown. In Figure 3, E3 has added 500

[12] See page 57: **https://www.pnmresources.com/~/media/Files/P/PNM-Resources/rates-and-filings/PVNGS%20Leased%20Capacity/8-2021-04-02-Phillips-Exhibits-Aff.pdf**.

MW of available hourly capacity from Mid-C during the outage events in the Base Case and removed 500 MW of perfect capacity from the PSE system.

Figure 2. Dispatch Plot, Week of January 25 (2027), PSE IRP Base Case

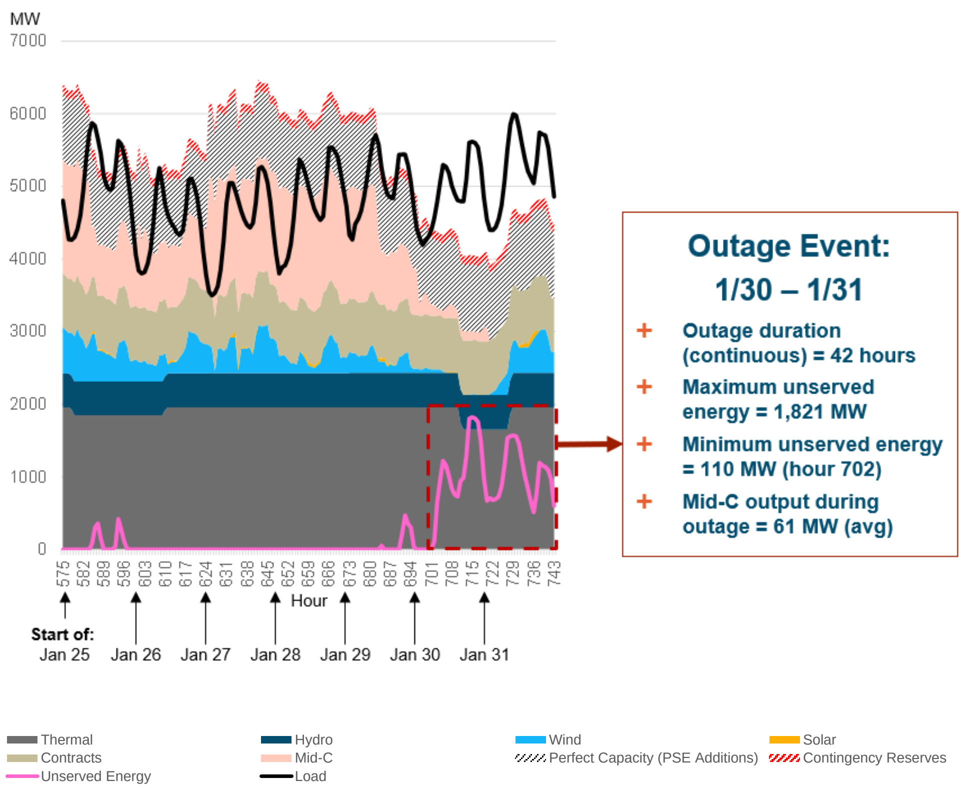
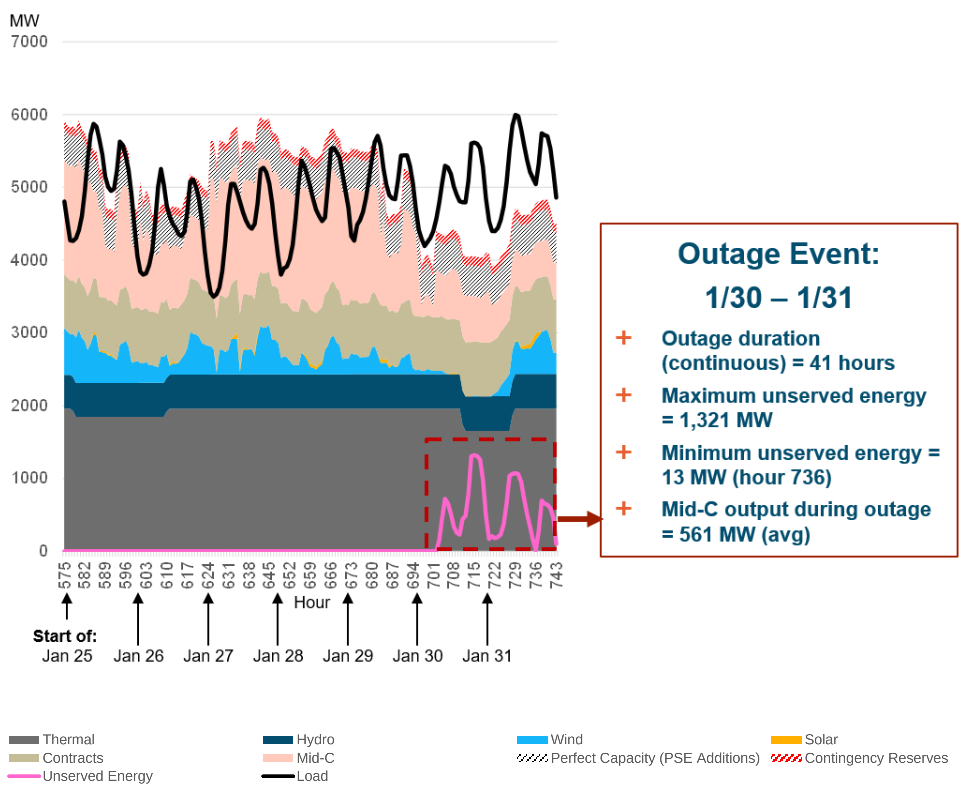


Figure 3. Dispatch Plot, Week of January 25 (2027), PSE IRP Base Case With 500 MW of Additional Mid-C Output and 500 MW Reduction of Perfect Capacity



As shown above, modifying the PSE Base Case so that Mid-C output is increased by 500 MW during unserved energy events reduces the duration of the 42-hour outage by only 1 hour, illustrating the impact of Mid-C on the outage characteristics against which battery storage is tested. However, it can also be seen that increasing the Mid-C market availability by an additional 500 MW would reduce outage durations substantially by effectively segmenting the long-duration outage shown above into multiple smaller-duration outages.

4.2.3 E3 CONCLUSION

To assess the potential impact of changes in PSE's approach to the external market on ELCC values, E3 recommends an additional GENESYS model run (and subsequent calibration with the WPCM model) where reliability-driven capacity is added to the broader region to achieve a 5% LOLP, as well as the PSE system. PSE should then perform ELCC calculations with a reliable system (to a 5% LOLP standard) where both the Mid-C market and PSE system are in a reliable state. How the battery storage ELCCs change could inform how PSE possibly rethinks its current modeling of the Mid-C market. If the changes to ELCC results are negligible then PSE would be comfortable that its current modeling is sufficient. If the ELCC results change significantly then broader consideration would need to be given to what reliability standard (and relatedly how much added reliability-driven capacity) is reasonable to assume given PSE's expectations for future capacity additions and retirements in the region.

To be clear, E3 is not recommending at this time that PSE make resource planning decisions based on this new GENESYS run, but rather to understand whether this single assumption about reliability in the regional system is a key driver of battery ELCC results.

4.3 Hydro Operations

4.3.1 ISSUE DESCRIPTION

E3 investigated whether PSE's approach to modeling hydropower operations is impacting its ELCC results in general, and battery storage ELCC results in particular.

4.3.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

PSE models the output of its own hydro plants (Baker River Project and Snoqualmie Falls), as well as its hydro contracts with the Chelan, Douglas and Grant PUDs, as a fixed hourly shape rather than a dispatchable (flexible) resource. This shape is aligned with the streamflow data inherent in the 80 hydro draws that are assumed in GENESYS and the hydro in the broader PNW region, and results in a single MW value being modeled in every hour of a single day and draw. This single MW value is the maximum available capacity in any hour within that day within that draw, the implicit assumption being that PSE could rely on its owned and contracted hydro to dispatch up to its maximum available capacity in a given hydro year during any time period in which a resource shortfall is possible.

In typical resource adequacy modeling and ELCC calculations across the industry, hydro is modeled with the extent of its dispatchable (i.e. not run-of-river) capabilities. Further, energy limitations are typically accounted for in modeling of hydro resources.[13] In reality, PSE's hydro resources cannot always dispatch to their maximum capacity to meet a long duration outage event (e.g., the 42 hour event shown above) due to water availability constraints. At the same time, PSE generally has flexibility on a diurnal time scale to dispatch its hydro resources to avoid loss-of-load events. Thus, PSE's approach both overvalues hydro (by assuming it is always available at its max capacity) and does not account for its

[13] For a more detailed discussion of this in the Pacific Northwest context, see E3's 2019 analysis: https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf.

diurnal flexibility, which would compete with energy storage to fulfill a limited need for short-duration services.

To illustrate the impact of changes in PSE's approach to modeling hydro operations, E3 generated the dispatch plots below from the week of January 14, 2027 in the PSE Base Case. This week was chosen because it contains multiple shorter-duration outages in draw 1687 (out of 7040), representing the combination of hydro calendar year 1947 (in which streamflow was the lowest of all 80 hydro years) and temperature calendar year 1943. In Figure 4, PSE's modeled dispatch is shown. In Figure 5, E3 has modified the capabilities of hydro resources to operate with energy limitations (50% capacity factor, pmin of 25%) and dispatch capabilities (i.e. output can be increased to pmax when there is unserved energy).

Figure 4. Dispatch Plot, Week of January 14 (2027), PSE IRP Base Case

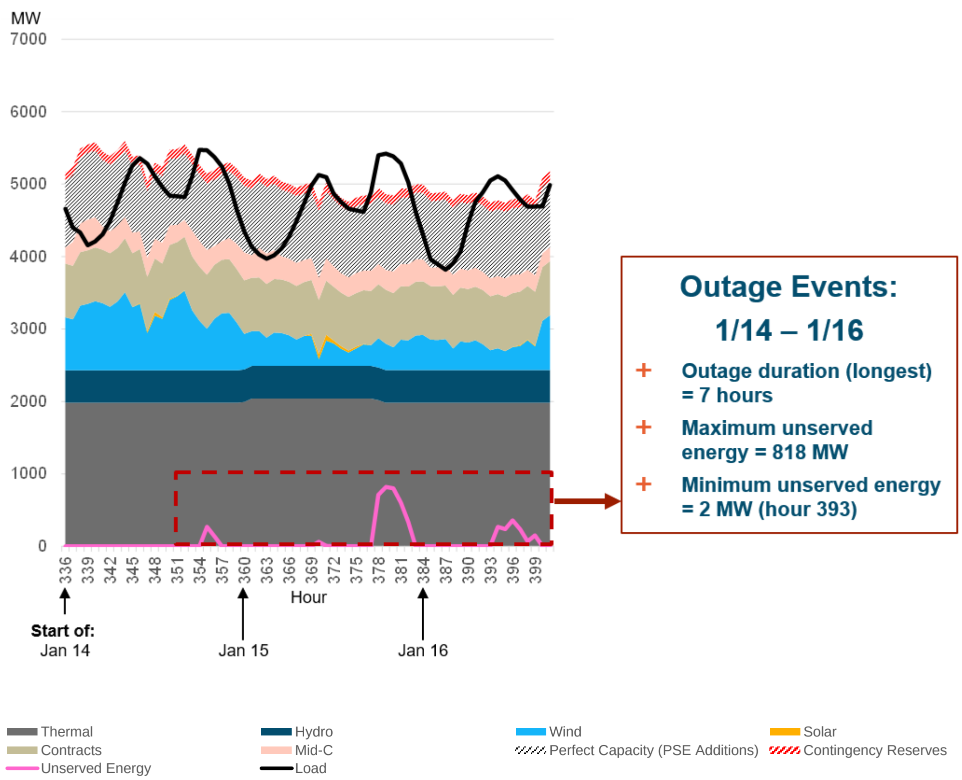
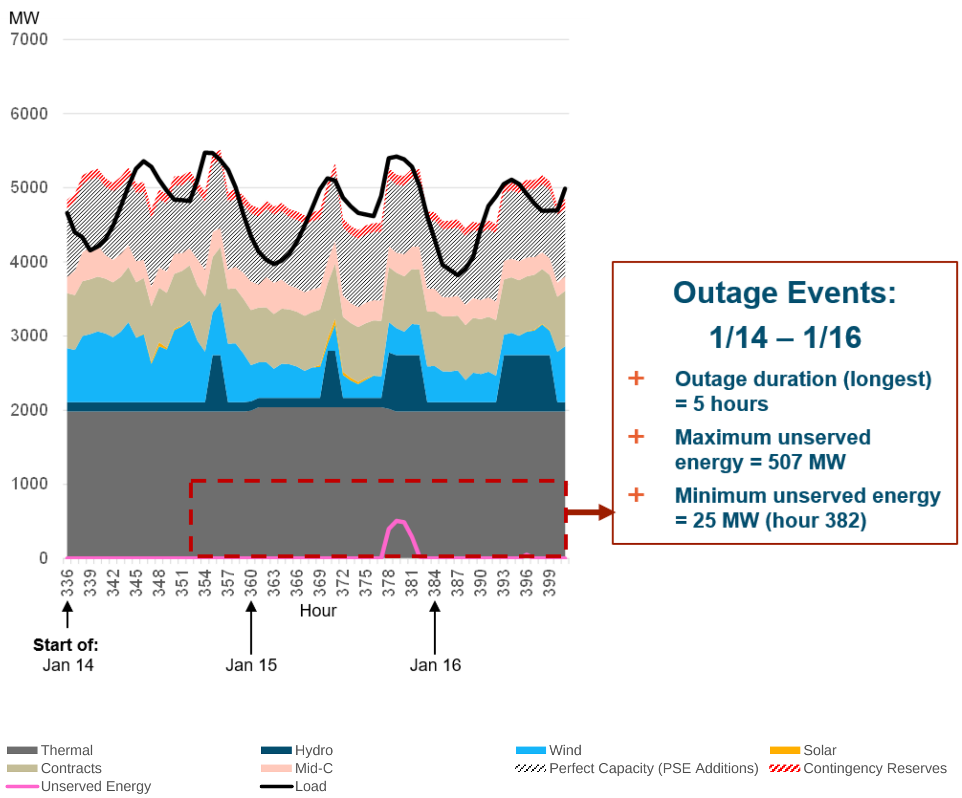


Figure 5. Dispatch Plot, Week of January 14 (2027), PSE IRP Base Case With Dispatchable and Energy-Limited Hydro Resources



As shown above, modifying hydro resources so they are energy-limited and dispatchable illustrates the ability of hydro to minimize unserved energy needs over shorter-duration periods (e.g., 4-6 hours).

4.3.3 E3 CONCLUSION

A lack of dispatchability and considerations of energy limitations both lead to an overestimation of storage ELCCs. If the hydro resources were modeled as dispatchable, this would enhance the operational capability of a competing (and likely more robust) energy-limited resource. This would, in turn, reduce the ELCC estimates for battery storage resources. If the modeling were enhanced to add energy limitations this would remove energy from the system, reducing the energy available for battery resources to charge, leading to lower ELCC estimates.

For future IRP cycles, E3 recommends that PSE update its modeling to incorporate hydro dispatch capabilities and hydro energy limitations. E3 recognizes, however, that modeling hydro as flexible is highly complex, as the flexibility depends on water conditions, operational constraints, and other factors that are difficult to quantify in a planning model.

4.4 Resource Correlations

4.4.1 ISSUE DESCRIPTION

E3 investigated whether PSE applies appropriate correlations to different resources, between resources and load, between hydro and regional market purchases and between weather and load in its modeling.

4.4.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

E3 found the following:

+ PSE preserves the correlation between solar and wind generation by using aligned wind speed and solar irradiance data from NREL.
+ PSE preserves the correlation between weather and load by using 88 years of temperature data and correlating this data with historical load. PSE uses several variables to generate its load forecast: population,

unemployment rates, retail rates, personal income, total employment, manufacturing employment, consumer price index (CPI), U.S. Gross Domestic Product (GDP), transmission and distribution losses, and weather data from Sea-Tac Airport.

+ PSE preserves the correlation between hydro and regional market purchases through modeling in GENESYS. This captures regional worst-case conditions likely to impact both PSE and external hydro resources and is important given that roughly 30% of PSE's 2022 peak capacity need is expected to be met by the short-term market.
+ Through modeling in GENESYS and WPCM, load and hydro are not correlated but rather permutated across 7040 draws (88 temperature years, 80 hydro years). Correlating weather and hydro is likely not appropriate: day-of weather conditions are unlikely to drive hydro resource availability, which is driven by snowpack and not single-day temperature spikes or dips.
+ No correlation is being modeled between weather and renewable (solar and wind) output, nor between load and renewable output.
    - The renewable output profiles are determined exogenously by taking samples of NREL data from potential development sites and then taking the median 250 samples. These sets of 250 samples of wind and solar profiles are then randomly applied to the 7040 temperature/hydro draws.

4.4.3 E3 CONCLUSION

The correlations being applied between wind and solar, as well as between weather and load, are reasonable and aligned with industry practice. Further, the permutation of hydro output and weather is also aligned with how other reliability forecasting models approach the same inputs (e.g., SERVM, E3's RECAP model).

Correlations between weather/load and wind/solar output are traditionally used in resource adequacy system modeling, which helps capture conditions which may drive loss-of-load events. In the Pacific Northwest, this would primarily result from intense cold weather driving increased demand and decreased renewable output. For future IRP cycles, E3 recommends utilizing weather-matched load that is aligned with wind and solar data. This will impact the ELCC results for wind and solar resources (see Appendix for additional detail) but should not have a major impact on storage ELCCs, which are largely driven by high load and low hydro events.

4.5 Temperature Data

4.5.1 ISSUE DESCRIPTION

E3 investigated whether the temperature data used by PSE as an input in its resource adequacy modeling is impacting its ELCC results.

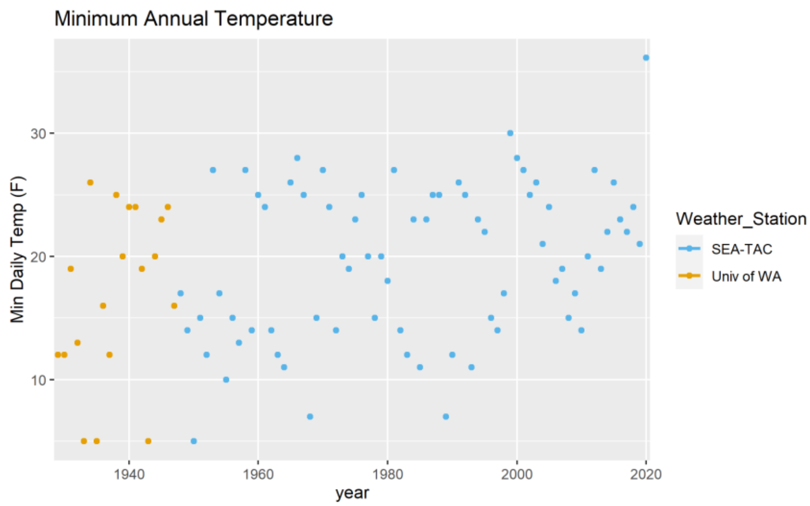
4.5.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

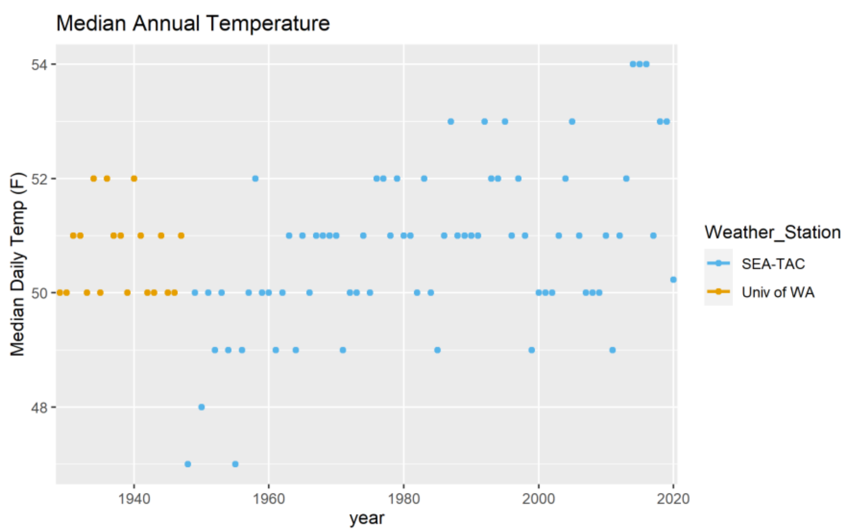
PSE uses 88 years of hourly temperature data (1929-2016) to inform its historical load forecast. Much of this hourly temperature data comes from the Sea-Tac Airport. However, Sea-Tac temperature data is only available from 1948 onward, following its construction, so data prior to 1948 is synthesized using daily high and low temperatures from the University of Washington weather station and hourly shapes from Sea-Tac data.

This brings up important questions regarding whether the synthesized hourly temperature data is having an impact on PSE's modeling and ELCC analysis. Unlike the outage events across hydro input years that are relatively evenly distributed, outage events in PSE's modeling are not evenly distributed across temperature input years. 33% - 35% of the simulated draws that have loss of load events in January 2027 and January 2031 occur in the temperature years prior to 1948, a period representing 21% of all weather years.

However, E3 analyzed this pre-1948 temperature data and found that it is reasonable and does not demonstrate any apparent bias compared to the other temperature years that would unfairly impact ELCC results. The minimum annual temperatures, as well as the median temperatures do not show a clear bias in the data that is formed with the synthesized data.

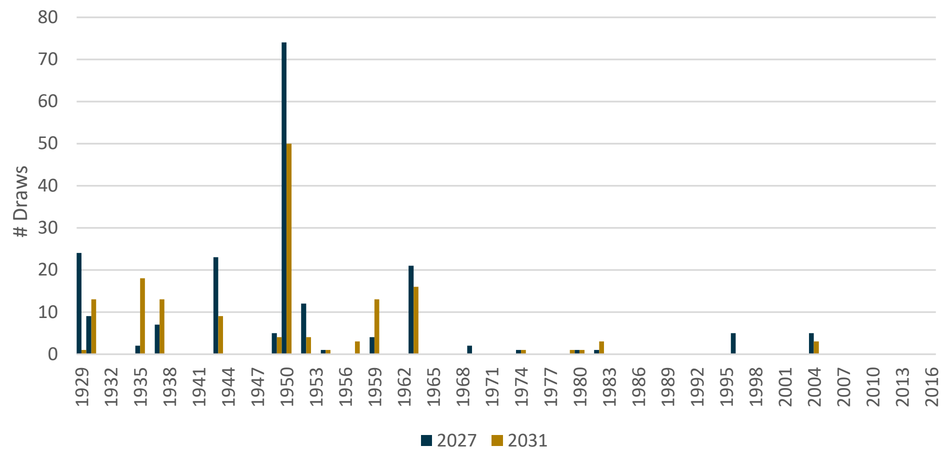
Figure 6. PSE Temperature Year Data, by Source





But looking at the temperature data further reveals that nearly 95% of the simulated draws that have loss-of-load events in January 2027 and January 2031 occur in the first half of the temperature years, prior to 1972 (see Figure 7).

Figure 7. Number of PSE Base Case Draws With Loss of Load Events, by Temperature Year, January 2027 and 2031



This raises important questions regarding whether, given that PSE is a winter-peaking system, there are clear warming trends that make the use of temperature data as far back as 1929 less useful. Moving forward, PSE's winter peaks may be reduced relative to summer peaks based on more recent climate warming trends, which has the potential to impact PSE's resource planning.

Including warming trends in load modeling is an evolving area of research and application and there is no prevailing industry standard. Furthermore, there is precedent in the PNW region for using 88 historical years of temperature data in GENESYS modeling, in line with the modeling by the NPCC.

A Temperature Sensitivity was modeled in PSE's 2021 IRP. Data was taken from three models that the NPCC has been using in its resource adequacy analyses that account for warming trends in the PNW region. This change only impacted the energy demand forecast used in PSE's resource adequacy modeling, but importantly it changed the nature of the demand profile and lowered winter peaks. Given that PSE is a winter-peaking system, this results in less reliability-driven capacity needed to start the ELCC analysis. See Table 6.

Table 6. Peak Capacity Need in PSE 2021 IRP[14]

Figure 7-32: Peak Capacity Need

	Base	Temperature Sensitivity
2027 peak need	907 MW	328 MW
2031 peak need	1,381 MW	1,019 MW

Given the change in the demand profiles and the amount of reliability-driven capacity that is added to the system, this then results in much different ELCC results. See Table 10 in Appendix for a comparison of PSE's ELCC results in its Base Case and Temperature Sensitivity.

4.5.3 E3 CONCLUSION

PSE's synthesis of temperature data from the University of Washington appears reasonable based on data E3 has reviewed.

E3 recommends that PSE analyze the impact of the Temperature Sensitivity shown in its IRP on the current RFP and investigate potential modifications of the temperature data set to reflect a changing climate in light of its findings. This is especially relevant to the bid-specific analysis that will be conducted in Phase 2

[14] PSE Final 2021 IRP, pg 7-45.

of the RFP, but can also inform future IRP cycles. Specifically, PSE should investigate:

(1) Whether the use of two different weather stations to derive temperature data at different times introduces bias into the analysis. This can be done by analyzing the temperature data from the time period when data from both weather stations is available and performing statistical tests to determine whether the two data sources can be considered part of the same data set, or whether there are statistically significant differences in the mean, median, or standard deviations.

(2) Whether PSE should truncate the amount of temperature years used to inform its load data if it believes that earlier temperature years are no longer applicable given a changing climate, and where this truncation might be most reasonable.

4.6 Generic Battery Storage Characteristics

4.6.1 ISSUE DESCRIPTION

E3 investigated whether the generic operating characteristics and capacity contributions of battery storage resources reflected in PSE's ELCC calculations are reasonable.

4.6.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

PSE assumes round trip efficiency (RTE) of 82% - 87% for generic Li-ion battery storage resources and calculates one-way efficiency applied to both charging and discharging of the storage. During the charging process, the maximum charging capacity is nameplate capacity and the state of charge (SOC) increase is (Nameplate Capacity) x (1 – One Way Efficiency). During the discharging process, the maximum discharging capacity is nameplate capacity and the SOC decrease is (Nameplate Capacity) x (1 + One Way Efficiency).

Besides RTE, PSE also applies the minimum state of charge (SOC) for battery storage when calculating storage ELCC. Minimum state of charge (SOC) for battery storage is 20% in PSE's modeling.

Both RTE and minimum SOC assumptions in PSE's model will decrease the ELCC of storage. For the RTE assumption, even though the RTE input is reasonable, the duration of the storage is de-rated due to the size of the energy capacity. For example, for a battery with 4 hours duration and 100 MW of nameplate capacity, the energy capacity is assumed to be 400 MWh. However, during the discharging process modeled by PSE, it takes less than 4 hours to deplete the storage, which is different from the common convention of storage duration. A typical practice is to expand the energy capacity by the efficiency losses so that the discharging duration at nameplate capacity can achieve the target duration. In addition, the minimum SOC assumption used in PSE's modeling does not align with the minimum storage limits presented in PSE's HDR report (see Table 7).

Table 7. Battery Specifications in PSE's Generic Resource Cost Report[15]

Puget Sound Energy | Generic Resource Costs for IRP
Report Number: 10111615-0ZR-P0001 Rev. 4

Table 9.3-1. BESS Performance Comparison

Parameter/Technology	Lithium Ion		Vanadium Redox Flow	
Capacity (MW)	25	25	25	25
Max Storage Limit (MWh)	50	100	100	150
Min Storage Limit (MWh)	2	2	2	2
Leakage Rate (% /hr)	0.05%	0.05%	0.00%	0.00%
Discharge Duration (hrs)	2	4	4	6
Recharge Time (hrs)	2.5	4.5	4.5	6.5
Round Trip Efficiency	82%	87%	73%	73%
Cycle Life (2 cycle/day 20 yrs)	14,600	14,600	14,600	14,600
Expected Annual Availability	98%	98%	95%	95%

4.6.3 E3 CONCLUSION

PSE's round-trip efficiency assumptions are reasonable.

PSE's application of minimum SOC and one-way efficiency both impact battery storage's maximum and overall potential ELCC results in the RFP context.

E3 recommends that:

[15] Page 65: https://oohpseirp.blob.core.windows.net/media/Default/PDFs/HDR_Report_10111615-0ZR-P0001_PSE%20IRP_Rev4%20-%2020190123).pdf.

1) PSE models battery storage in a manner more aligned with industry standards, such that storage can discharge at maximum capacity for X hours if the storage is defined as having X hours of duration; and

2) PSE aligns the presentation of ELCC values with the characterization of minimum, maximum, and nameplate MW values in its RFP documentation.

If these recommendations are reflected, no additional ELCC analysis is required.

4.7 Battery Storage Dispatch

4.7.1 ISSUE DESCRIPTION

E3 investigated whether the dispatch of the generic battery storage resources tested for ELCC calculations is reasonable.

4.7.2 PSE METHODOLOGY AND INDUSTRY PRACTICE

Proper storage dispatch behavior has a direct and significant impact on storage ELCC results. Standard practice is for battery discharge to occur whenever possible during a loss of load event in utility resource adequacy modeling.

In PSE's Base Case, the 4-hour Li-ion battery discharges in 265 of a total of 7040 simulation draws in 2027. In January 2027 in the Base Case, there are 197 simulated draws with loss of load events, with a total of roughly 2,900 hours with unserved energy. Furthermore, each draw in the January 2027 Base Case that has unserved energy in any hour, also has battery discharge at some hour in the draw.

E3 investigated whether storage dispatch within a given draw conforms to our expectation that storage dispatch occurs in response to loss of load events. In general, storage dispatch behavior is reasonable and in line with expectations: when there is an unserved energy event, storage dispatch occurs to the extent allowable by capacity.

As part of this investigation, E3 confirmed that PSE modeling includes the ability to call upon reserves from the Northwest Power Pool (NWPP) Reserve Sharing Program during the first hour of an unserved energy event, to the extent there is energy available in the external market.[16] Furthermore, while 50% of contingency reserves are typically added to load in PSE's resource accounting, this can flip to a subtraction from load in the first hour of a loss of load event, after which PSE must replace these reserves with either imports or increased production from its internal units.

It was beyond the scope of the current engagement for E3 to audit each of the calculations used by PSE to account for the net impact of reducing perfect capacity, adding battery storage capacity, and calling upon the NWPP Reserve Sharing Program on unserved energy events. E3 was able to confirm that PSE's accounting for unserved energy in its Base Case without battery storage reflects all the relevant dynamics as expected, based on data E3 reviewed. In battery storage scenarios, PSE modeling assumes a limit on the ability to call upon Assistance Reserves from the NWPP Reserve Sharing Program in response to the first hour of a loss-of-load event of once per day; this is inconsistent with Base Case modeling. If this assumption is relaxed, the duration of a second (or third, or

[16] For more information, see: **https://www.nwpp.org/about/workgroups/2**.

fourth, or fifth, etc.) outage within a given day would be reduced by one hour. However, based on data E3 has reviewed from PSE's January 2027 scenarios with battery storage, the impact of relaxing this assumption on ELCCs is likely to be minor, as this only alters the number of hours with unserved energy by roughly 1% (from a base of roughly 2,700 hours under battery storage scenarios). Furthermore, there is a rationale for assuming that multiple outages within a given day are unlikely to be remedied by energy available at Mid-C, since this would likely occur during periods when the region is stressed and Assistance Reserves are less likely to be consistently available. However, this inconsistency between Base Case and battery storage scenarios is a minor disadvantage for battery storage ELCCs.

4.7.3 E3 CONCLUSION

In general, E3 finds that PSE's modeling of storage dispatch is reasonable and reflects the appropriate dynamics for calculating ELCC. As noted above, there is credible rationale for PSE's treatment of the first hour of a loss of load event in the Base Case, given the NWPP Reserve Sharing Program.

E3 recommends that PSE align its treatment of the first hour of loss-of-load events across its Base Case scenarios without battery storage and its scenarios with battery storage to reflect the proper utilization of the NWPP Reserve Sharing Program and consistent treatment of its own Contingency Reserves, as this inconsistency creates a minor disadvantage for battery storage ELCCs.

5 Additional Topics Reviewed

In addition to the key issues covered above, E3 investigated the questions listed below, representing inquiries PSE has received from stakeholders in the RFP process. For each question, E3's response is noted.

5.1.1 GENERAL

Why are PSE's ELCCs lower than those of other utilities, such as PGE and California utilities?

While E3 did not conduct a deep-dive analysis into the ELCC calculations and methodology of other utilities in the western U.S., PSE differs from many other utilities in general, and even from other utilities in the western region. First, PSE is a winter-peaking system, while many other utilities, including PGE, are summer-peaking systems. Secondly, hydro dominates the regional system, which has enabled the Pacific Northwest to build relatively fewer gas-fired peaking resources. This means that during a drought year, the energy deficit becomes the biggest driver of long duration loss of load events, which has a negative impact on battery storage ELCC results.

Are the operating data for different non-storage technologies reasonable?

E3 recommended that PSE utilize output shapes for wind and solar resources that are correlated with temperatures in the PSE service area. E3 did not uncover any other issues with non-storage operating data.

Are the load shapes used in PSE's analysis reasonable?

E3 recommends that PSE investigate (1) Whether the use of two different weather stations to derive temperature data at different times introduces bias into the analysis, and (2) whether it should truncate the amount of temperature years used to inform its load data if it believes that earlier temperature years are no longer applicable given a changing climate, and where this truncation might be most reasonable.

5.1.2 PUMPED STORAGE

Is it unreasonable for PSE to limit pumped storage resources' operating range (or "state of charge") to 70% of the resource's storage capacity?

E3 did not specifically analyze PSE's input assumptions for pumped storage resources. The key issues covered in this report in the context of battery storage are relevant to the discussion of pumped storage, and these issues (e.g., hydropower operations as a supply factor, temperature data as a demand factor) will also impact ELCCs for pumped storage. In general, E3 normally assumes that pumped storage units can be fully dispatched, but also recognizes that sometimes specific characteristics of specific pumped storage plants can require them to hold back a portion of their energy in their respective ponds.

5.1.3 HYBRID RESOURCES

Does PSE unreasonably limit hybrid resources by only allowing them to charge from renewables over the entire lifecycle of the resource?

E3's analysis and review did not specifically focus on the operating parameters of PSE's generic hybrid resources (battery storage paired with another resource). The key issues covered in this report in the context of battery storage are relevant to the discussion of hybrid resources. These key issues (e.g., treatment of Mid-C external market availability) will also impact ELCCs for hybrid resources. In general, E3 recommends that the energy storage component of hybrid resources should be allowed to be charged by the grid after the window for investment tax credit eligibility expires, subject to the combined interconnection limit.

5.1.4 MARKET LIMITATIONS

Does the reduction in availability of market purchases in PSE's IRP artificially constrain the ability of storage resources to meet PSE's capacity needs?

As discussed above, PSE's treatment of the Mid-Columbia (Mid-C) trading hub does impact its ELCC calculations in general and battery storage ELCCs in particular. As detailed above, E3 is recommending additional modeling where the external region is brought up to a 5% LOLP reliability standard and the ELCC analysis is re-run under those conditions. The result of that analysis will inform if any further changes are needed for how PSE models the external market.

Does the IRP impose a market import limitation across the full 24-hour window on all days in January and February instead of only during "super-peak" and "heavy-load" hours?

Based on the data that E3 reviewed, as well as conversations with PSE, the high level import limit did not change based on month or super-peak or heavy-load hours. Market import curtailments are derived from NPCC GENESYS model runs.

How does PSE's analysis reflect transmission constraints?

Transmission constraints are defined by the physical capability to import power into PSE's system, as well as the resources and contracts that have rights on those lines and could therefore potentially reduce the ability for PSE to make short-term market purchases in some hours. These short-term market purchases are then incorporated into PSE's ELCC analysis as a reliability resource and are a key driver of longer duration loss-of-load events and low storage ELCC results.

5.1.5 BATTERY STORAGE

Are the ELCCs for Li-ion (2-hour and 4-hour) overly conservative, considering that the resources are stand-alone and charging and discharging schedules will not be constrained by a co-located renewable generation resource?

The reason for low battery storage ELCCs is not whether they are charged by renewable resources or not, but rather the nature and length of the outages on PSE's system. Many outage events, even after PSE's own system has been brought up to a 5% LOLP standard by adding perfect capacity, are very long in duration. See E3's discussion of PSE's treatment of Mid-C for more details.

Does PSE's IRP portfolio modeling preference for 2-hour battery storage conflict with an industry-standard of 4-hour battery?

PSE calculated ELCC values for multiple generic battery storage resources including a two-hour and four-hour Li-ion battery, as well as a four-hour and six-hour flow battery.

What changed between the cases utilized in 2020 and amended in 2021 that resulted in a decrease in the assessed ELCC of energy storage?

E3 did not analyze the ELCC calculations from the last IRP. However, the first reference year for which ELCC results were shared was updated from 2022 to 2027. Given that reliability-driven capacity is not added to the external market to make up for growing load and hydro shortfalls, an earlier reference year (2022 compared to 2027) would presumably have fewer long duration outages which would benefit battery storage ELCCs.

5.1.6 OTHER

Are PSE's ELCC estimates inclusive of the possibility of forced outages during a peak event?

Yes, forced outage rates are accounted for in the modeling and ELCC analysis.

How did the temperature sensitivity scenario in the 2021 IRP impact PSE's resource plan?

E3's understanding is that the temperature sensitivity was a stand-alone analysis that did not directly inform resource plans resulting from the 2021 IRP. However, as noted in this report, E3 recommends that PSE reevaluate the appropriateness of its current approach to considering temperatures in developing load shapes.

6 Summary

E3 finds that PSE's general approach to ELCC calculation is reasonable. While PSE's treatment of Mid-C does disadvantage battery storage ELCCs, there is no industry standard for how to address the issue of external market equilibrium, and whether it is appropriate to assume an adequate regional system is a real and difficult question. Beyond the question of how to treat the external market, the other topic requiring immediate attention in the current RFP process is the presentation of generic battery storage operating characteristics, which does not require changes in PSE's ELCC calculation methodology. While it would be ideal to address the treatment of Contingency Reserves and PSE's participation in the NWPP Reserve Sharing Program under its battery storage scenarios, this may require continued analysis beyond what is feasible within the current RFP timeline. Moving forward, PSE's treatment of resource correlations, temperature data, and hydropower operations merit additional analysis and potential adjustments, but without additional analysis it is unclear if changes in the treatment of these topics will produce significant changes in battery storage ELCCs; in the case of hydropower operations, updates to the PSE modeling approach could produce a reduction in battery storage ELCCs.

E3 recommends that PSE do the following before conducting the portfolio analysis in the RFP:

4) Conduct an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP standard before recalculating ELCC;

5) Restate ELCC values for battery storage in a manner more aligned with industry standards, such that storage can discharge at maximum capacity for X hours if the storage is defined as having X hours of duration, and align the presentation of ELCC values with the characterization of minimum, maximum, and nameplate MW values in RFP documentation; and

6) Re-calculate battery storage ELCCs under the assumption that PSE's treatment of its own Contingency Reserves and the NWPP's Reserve Sharing Program is the same as in PSE's Base Case without battery storage, and investigate the significance of the revised results.

E3 recommends that PSE do the following in future IRP cycles:

4) Utilize weather-matched load that is aligned with wind and solar data;

5) Reevaluate its current approach to considering temperatures in developing load shapes based on (1) the use of two different weather stations, and (2) the changing climate;

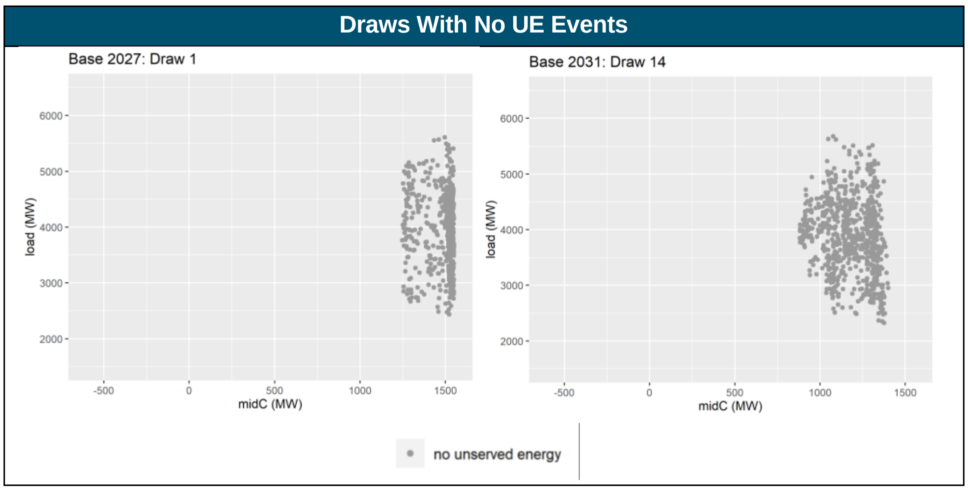
6) Update modeling to incorporate hydro dispatch capabilities and hydro energy limitations.

E3 expects that even in the context of the recommendations above, battery storage ELCCs are likely to be relatively low in a hydropower-dependent region like the PNW compared to other regions. To confirm this judgment, however, E3 recommends the additional steps above.

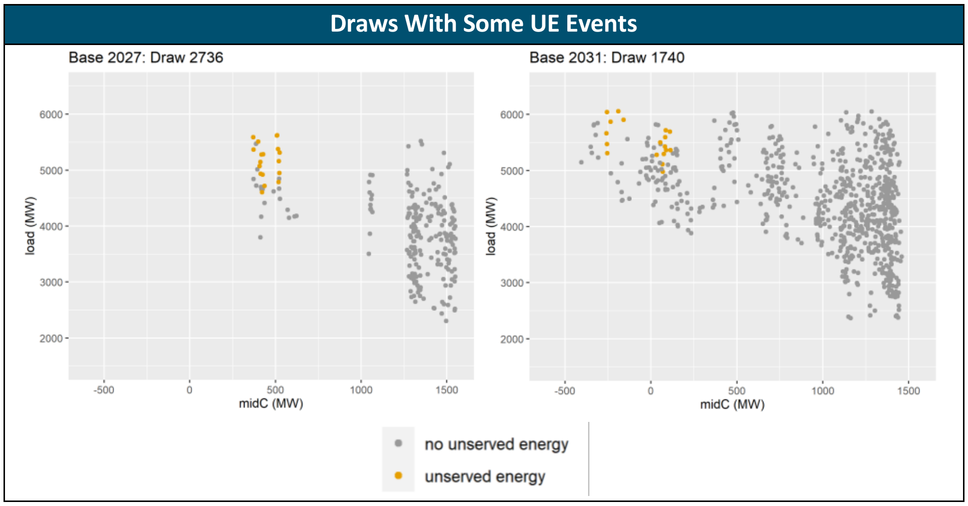
7 Appendix

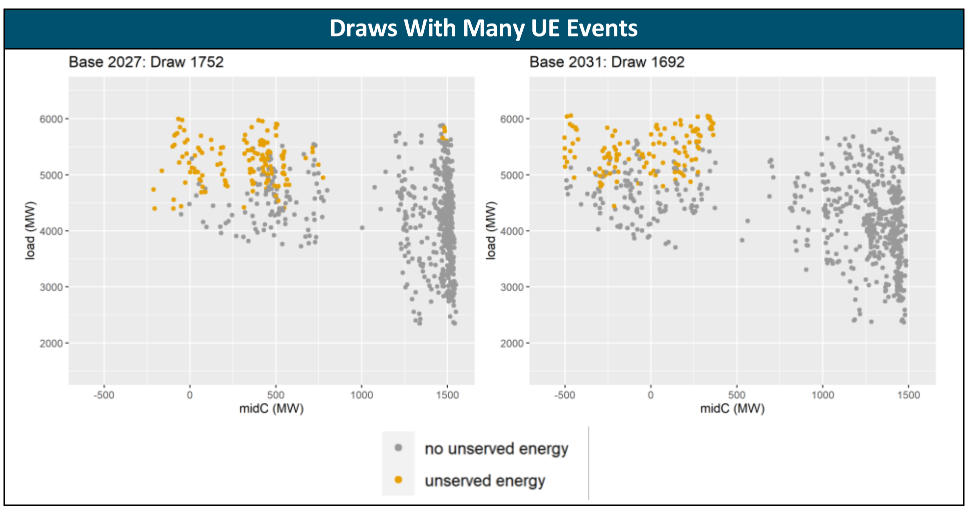
7.1 Mid-C Data Visualization

Figure 8. Mid-C Output During Draws With No, Some, and Many Unserved Energy Events[17]



[17] PSE IRP data. E3 analysis.


Draws With Some UE Events
Base 2027: Draw 2736
Base 2031: Draw 1740
load (MW)
midC (MW)
no unserved energy
unserved energy

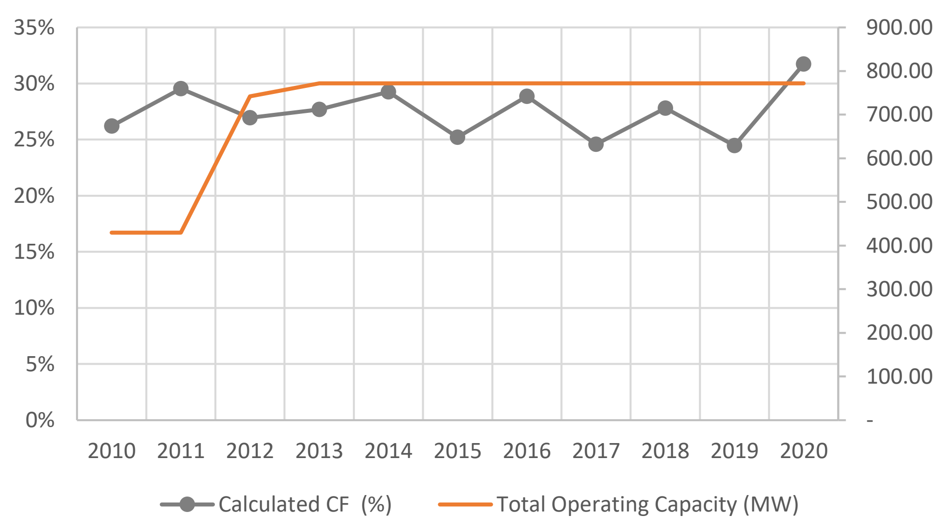

Draws With Many UE Events
Base 2027: Draw 1752
Base 2031: Draw 1692
load (MW)
midC (MW)
no unserved energy
unserved energy

7.2 Resource Correlations

7.2.1 SOLAR AND WIND CAPACITY FACTORS

E3 analyzed PSE's historical wind data to assess the historical correlation of wind production and load. While PSE does have some solar capacity (0.5 MW), the amount was considered too small for inclusion in this analysis. PSE's wind assets displayed an average capacity factor of 27% from 2010-20.

Figure 9. PSE Wind Capacity Factor vs Operating Capacity[18]



[18] SNL. https://www.capitaliq.spglobal.com/web/client?auth=inherit&overridedcdc=1&#company/plantportfoliosummary?ID=4062485.

7.2.2 WIND CORRELATION WITH LOAD

In the highest load hours over the past 4 years, the wind fleet showed an average capacity factor of 18%. There appears to be a negative correlation between average wind fleet output (27% for the years 2010-20) and wind output during the highest load hours (18%).

Table 8. Historical Hourly Load and Wind Capacity Factor for PSE, 2017 – 2020[19]

Load Rank	Load (MW)	Wind CF	Actual Time
1	5431	19%	2/6/19 17:00
2	5419	36%	2/6/19 16:00
3	5380	13%	2/7/19 16:00
4	5306	19%	2/7/19 17:00
5	5247	20%	2/6/19 18:00
6	5227	13%	2/5/19 3:00
7	5226	31%	2/5/19 17:00
8	5226	31%	2/5/19 17:00
9	5210	45%	2/6/19 15:00
10	5198	6%	2/5/19 2:00
11	5160	34%	2/7/19 3:00
12	5155	12%	2/6/19 3:00
13	5154	0%	3/4/19 16:00
14	5150	2%	2/11/19 3:00
15	5135	15%	3/5/19 16:00
16	5132	2%	2/11/19 2:00
17	5126	27%	2/5/19 18:00
18	5108	8%	2/7/19 18:00
19	5105	14%	2/7/19 15:00
20	5101	5%	2/5/19 4:00

[19] EIA. https://www.eia.gov/opendata/qb.php?category=3390168&sdid=EBA.PSEI-ALL.NG.WND.H.

Figure 10. Plot of Historical Hourly Load and Wind Capacity Factor for PSE for 100 Highest Load Hours, 2017 – 2020[20]

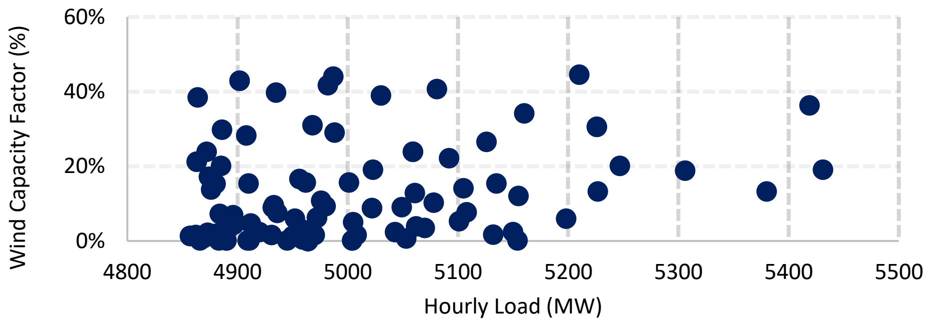


Table 9. Month-Hour Heatmaps of Wind Capacity Factor and Load Factors for PSE, 2017-2020[21]

Month-Hour Average Wind Capacity Factor (%)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	17%	17%	16%	16%	16%	16%	16%	15%	16%	15%	15%	15%	15%	16%	16%	16%	16%	15%	15%	16%	15%	15%	15%	15%
2	13%	13%	14%	15%	15%	14%	15%	15%	16%	16%	16%	16%	16%	15%	16%	16%	15%	14%	14%	13%	13%	13%	13%	13%
3	17%	16%	16%	16%	16%	16%	16%	17%	17%	16%	17%	17%	17%	17%	17%	17%	17%	17%	18%	18%	18%	18%	17%	16%
4	19%	20%	21%	22%	22%	21%	20%	21%	21%	20%	20%	20%	19%	18%	18%	17%	17%	17%	17%	17%	16%	16%	17%	19%
5	17%	19%	21%	22%	23%	23%	24%	23%	23%	22%	21%	20%	19%	19%	18%	17%	16%	16%	16%	16%	16%	16%	16%	16%
6	17%	19%	21%	23%	23%	24%	24%	23%	22%	22%	22%	20%	19%	18%	17%	16%	15%	15%	14%	14%	14%	14%	15%	15%
7	15%	18%	21%	23%	24%	24%	24%	23%	23%	21%	20%	18%	17%	16%	15%	13%	12%	11%	10%	10%	11%	12%	13%	14%
8	16%	17%	19%	21%	23%	23%	22%	20%	19%	19%	19%	18%	17%	16%	15%	14%	13%	12%	12%	10%	9%	10%	11%	13%
9	9%	12%	14%	15%	15%	15%	16%	17%	17%	17%	17%	16%	15%	14%	13%	11%	10%	9%	9%	8%	8%	8%	8%	8%
10	16%	17%	18%	19%	19%	19%	18%	19%	18%	18%	18%	17%	17%	16%	15%	15%	16%	14%	14%	15%	15%	16%	16%	16%
11	16%	16%	16%	17%	17%	18%	18%	17%	18%	18%	17%	18%	18%	17%	18%	18%	17%	17%	17%	16%	15%	15%	15%	15%
12	14%	15%	14%	15%	15%	16%	17%	18%	18%	18%	18%	17%	17%	17%	17%	16%	15%	15%	15%	15%	14%	14%	14%	14%

Month-Hour Average Load Factor (%)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	76%	79%	83%	83%	81%	78%	74%	69%	64%	61%	59%	59%	60%	62%	67%	73%	77%	79%	79%	79%	78%	77%	76%	75%
2	77%	79%	83%	85%	83%	81%	77%	71%	67%	64%	63%	63%	63%	66%	72%	78%	82%	83%	83%	82%	80%	79%	78%	77%
3	69%	70%	72%	75%	75%	72%	67%	63%	59%	58%	57%	58%	60%	64%	70%	76%	78%	78%	76%	74%	73%	71%	69%	68%
4	59%	60%	61%	61%	62%	60%	56%	51%	48%	47%	46%	47%	49%	54%	59%	63%	64%	64%	63%	62%	61%	60%	59%	58%
5	56%	57%	57%	57%	57%	56%	52%	48%	45%	43%	42%	42%	43%	46%	50%	53%	55%	56%	57%	57%	57%	56%	56%	55%
6	61%	62%	62%	61%	60%	59%	56%	51%	47%	45%	43%	43%	44%	46%	49%	53%	56%	57%	59%	60%	60%	60%	60%	61%
7	67%	68%	68%	67%	65%	64%	60%	55%	50%	48%	46%	45%	46%	48%	50%	54%	57%	60%	61%	63%	64%	65%	65%	66%
8	68%	70%	69%	67%	67%	65%	60%	55%	51%	48%	46%	45%	46%	48%	51%	54%	57%	60%	62%	63%	65%	66%	66%	67%
9	61%	63%	63%	63%	62%	58%	54%	49%	46%	45%	43%	43%	44%	47%	51%	54%	57%	58%	59%	60%	60%	60%	61%	61%
10	60%	62%	64%	64%	63%	59%	55%	51%	48%	46%	46%	46%	48%	52%	58%	62%	64%	64%	63%	62%	61%	60%	59%	59%
11	70%	73%	76%	76%	74%	71%	68%	63%	59%	56%	55%	55%	55%	58%	63%	68%	72%	74%	74%	73%	72%	71%	70%	69%
12	77%	81%	84%	83%	81%	79%	75%	70%	65%	62%	60%	59%	59%	62%	67%	72%	77%	79%	79%	79%	78%	78%	77%	76%

[20] EIA. https://www.eia.gov/opendata/qb.php?category=3390168&sdid=EBA.PSEI-ALL.NG.WND.H.
[21] EIA. https://www.eia.gov/opendata/qb.php?category=3390168&sdid=EBA.PSEI-ALL.NG.WND.H.

7.3 Temperature Data

Table 10. ELCC by Resource and by Sensitivity in PSE 2021 IRP[22]

WIND AND SOLAR RESOURCES	Capacity (MW)	ELCC Year 2027 Base Scenario	ELCC Year 2027 Temp. Sensitivity	ELCC Year 2031 Base Scenario	ELCC Year 2031 Temp. Sensitivity
Existing Wind	823	9.6%	6.8%	11.2%	6.7%
Skookumchuck Wind	131	29.9%	17.6%	32.8%	9.2%
Lund Hill Solar	150	8.3%	30.3%	7.5%	54.3%
Golden Hills Wind	200	60.5%	49.3%	56.3%	39.3%
Generic MT East Wind1	350	41.4%	28.5%	45.8%	28.1%
Generic MT East Wind2	200	21.8%	13.1%	23.9%	17.7%
Generic MT Central Wind	200	30.1%	23.1%	31.3%	20.9%
Generic WY East Wind	400	40.0%	29.1%	41.1%	32.7%
Generic WY West Wind	400	27.6%	27.2%	29.4%	34.0%
Generic ID Wind	400	24.2%	25.6%	27.4%	28.0%
Generic Offshore Wind	100	48.4%	38.6%	46.6%	27.6%
Generic WA East Wind	100	17.8%	7.8%	15.4%	12.0%
Generic WY East Solar	400	6.3%	13.5%	5.4%	32.5%
Generic WY West Solar	400	6.0%	16.2%	5.8%	36.3%
Generic ID Solar	400	3.4%	16.0%	4.3%	47.3%
Generic WA East Solar	100	4.0%	21.6%	3.6%	45.6%
Generic WA West Solar – Utility-scale	100	1.2%	7.6%	1.8%	20.2%
Generic WA West Solar – DER Roof	100	1.6%	7.6%	2.4%	19.4%
Generic WA West Solar – DER Ground	100	1.2%	7.6%	1.8%	20.2%
BATTERY STORAGE					
Lithium-ion, 2-hr, 82% RT efficiency	100	12.4%	34.2%	15.8%	36.0%
Lithium-ion, 4-hr, 87% RT efficiency	100	24.8%	66.6%	29.8%	68.8%
Flow, 4-hr, 73% RT efficiency	100	22.2%	61.6%	27.4%	63.8%
Flow, 6-hr, 73% RT efficiency	100	29.8%	79.2%	35.6%	84.8%
Pumped Storage, 8-hr, 80% RT efficiency	100	37.2%	89.2%	43.8%	97.8%
SOLAR + BATTERY RESOURCE					
Generic WA Solar, lithium-ion, 25MW/50MWh, 82% RT efficiency	100	14.4%	22.0%	15.4%	56.6%
Generic WA Wind, lithium-ion, 25MW/50MWh, 82% RT efficiency	100	23.6%	26.0%	23.0%	17.8%
Generic MT East Wind, pumped storage, 8-hr, 80% RT efficiency	200	54.3%	73.0%	57.7%	64.0%

[22] PSE Final 2021 IRP, pg 7-47.

PUGET SOUND ENERGY

PSE Response to Public Comments on ELCC Calculations and Use:

Appendix B. Index of Public Comments by Commenting Entity

#	Summary of Comment(s)
Columbia River Inter-Tribal Fish Commission	
1.1	***Topic: Puget Sound Energy needs adequate electricity supplies:*** The first Tribal Energy Vision in 2003 included recommendations to avoid another energy shortage that damaged fish and wildlife and the economy. In 2001, a drought—in combination with the Bonneville Power Administration's (BPA) commitment to serve more power than it could generate and electric industry manipulation of the California energy market—resulted in a power shortage. BPA eliminated protection measures as salmon migrated through the dams and significantly reduced funding for fish and wildlife restoration programs. The 2001 river actions resulted in significant losses of juvenile salmon. In 2001, just 6% of juvenile steelhead survived their in-river migration from Lower Granite Dam on the Snake River to Bonneville Dam; in most years the survival rate is 40% to 70%. These energy problems cost electricity consumers $4 billion.
1.2	***Topic: Puget Sound Energy should reduce peak electricity demands:*** There are quantifiable benefits to reducing peak loads. For the electrical system, lower demand on peaks translates into fewer capital resources that are needed to serve loads. The grid can serve the same total energy needs with fewer generating plants and a smaller investment in new transmission and distribution lines over time if peaks are lowered. Line losses and ancillary services can also be reduced with lower demand. Cutting peak demand will reduce damage to salmon and steelhead migration and reduce greenhouse gas emissions. Appendix E of the draft Energy Vision describes the high cost of the transmission and distribution system associated with meeting peak demand. For example, serving the highest 600 hours during a year (out of 8,760 hours) is estimated to cost between $0.50 and $1 per kilowatt hour, compared to the average costs residential customers pay of about 8¢ to 12¢ per kilowatt hour. These high transmission and distribution costs get averaged into everyone's electric bill. Reducing peak demand would also defer or eliminate the need for some new transmission and distribution systems. For example, BPA is planning to spend $730 million over the next five years to expand its transmission system6. Four investor-owned utilities have spent $6.8 billion over the past five years expanding their systems and other utilities are planning to expand their systems. These expansions will add significant costs and can adversely affect sensitive resources along power line routes7. The recommendations section of the draft Energy Vision describes actions that utilities should take to reduce peak demand, including energy efficiency, demand response, storage, electric vehicle charging, and changes in water heating and building heating and cooling.

#	Summary of Comment(s)
1.3	***Topic: The WUTC should adopt time-of-use pricing to reduce peak loads:*** The draft Energy Vision also includes recommendations for the region's public utility commissions to implement time of use pricing for all consumers based on the total costs of serving electricity needs. Currently, all commercial, industrial, and agricultural customers served by investor-owned utilities in California are required to be on a time-of-use plan. Residential customers can choose to be on a time-of-use plan, by contacting their utility. The California Public Utility Commission states: If customers have energy usage that can be shifted from peak hours to off-peak hours, they may be able to reduce their energy bill by switching to a time-of-use rate plan. For example, customers could run large appliances like dishwashers and washing machines at off-peak hours. Electric vehicle owners may also benefit from switching to a time-of-use rate plan if they charge their vehicles overnight. According to the California Public Utilities Commission, time-of-use pricing encourages the most efficient use of the electric energy system and can reduce the overall costs for both the utilities and customers by sending price signals about the actual cost to serve loads at different times. Time-of-use rates vary according to the time of day, season, and day type (for example, weekday, weekend, or holiday). Higher rates are charged during the peak demand hours and lower rates during off-peak (low) demand hours. In California, rates are also typically higher in summer months than in winter months. The California Independent System Operator has prepared a detailed analysis of the time of use periods in California. The California PUC states: "This rate structure provides price signals to energy users to shift energy use from peak hours to off-peak hours." California has implemented a default time of use rate system that will provide valuable experience. The WUTC should implement time-of-use rates to send an appropriate price signal that captures the dramatically different costs of using electricity during different times of the day.
1.4	***Topic: Puget Sound Energy should acquire all cost-effective energy efficiency:*** Energy efficiency programs reduce both peak demands and year-round energy needs. Energy efficiency has been proven as a reliable resource in the Northwest with costs that are less than half the cost of new gas-fired power plants. These programs save consumers money and reduce the emissions of pollutants that cause climate change.

#	Summary of Comment(s)
	Energy efficiency also reduces the region's seasonal storage needs because energy savings closely track energy demand. The "flexibility" of energy efficiency is extremely valuable. Energy efficiency programs have no adverse effects on fisheries or other tribal resources. The Northwest Power and Conservation Council's studies show that the cost to utilities of efficiency programs has been less than half of the cost of new generating resources. These resources reduce the region's costs of meeting additional electric energy demands and meeting needs associated with salmon restoration measures. According to the Council, the region has saved 7,000 average megawatts since 1978 through energy efficiency programs, codes, and standards. That is enough electricity to serve more than five million homes. The U.S. Energy and Employment Report shows that over 100,000 people are employed in our region working with energy efficiency at utilities, the Northwest Energy Efficiency Alliance (NEEA), the Energy Trust of Oregon, state agencies, and at the many trade allies and contractors that work to implement programs and deliver efficiency services. CRITFC recommends that utilities should maintain or expand the energy efficiency program targets that were in the Seventh Power Plan, with emphasis on weatherization programs for low income households. Section 3 of the draft Energy Vision provides additional detail for this recommendation.
1.5	***Topic: The WUTC should review and integrate policies to reduce greenhouse gases:*** Solar and wind development can significantly reduce greenhouse gas emissions. Lower costs, higher efficiencies, and current federal and state policies are driving an increase in these resources. The capital cost of renewable resources developed to meet state Resource Portfolio Standards (RPS) and/or clean energy standards is being recovered in rates, so when these resources produce power in excess of "native load need," they can be sold at very low, zero, and even negative costs. As a result of the federal Production Tax Credit, Investment Tax Credit, and Renewable Energy Credits, resource producers will pay others to take their electricity so they can get the credits. For all these reasons, they do not need to recover their capital cost "in the market." As a result, the forecasts of future wholesale *energy* prices for most hours of the day and for nearly all months of the year across the WECC will continue to be low. These low prices depress the value of energy efficiency's *energy* (kwh) savings which in turn increases the cost of energy efficiency as a source of *capacity* savings11. Therefore, while these tax policies, cost-recovery practices, and RPS are intended to promote the development of non-greenhouse gas emitting generating technologies, they have the unintended effect of reducing the amount of energy efficiency that is cost effective. Even though some energy efficiency measures can reduce greenhouse gas emissions at a lower cost per ton than the cost of doing so with renewable resources, the existing incentives (tax credits, RECs) and electricity market structures make the energy efficiency measures appear more expensive. These policies may also

#	Summary of Comment(s)
	not adequately address the high economic and environmental effects of transmission and distribution lines. Policies should address all of these issues in the development of an integrated set of least-cost options for reducing greenhouse gas emissions, whether that be energy efficiency or renewables resources or most likely a combination of these resources. Unfortunately, under the current policy environment the least cost mix of resources to reduce greenhouse gases is not likely to be developed. These policies and standards can also have unintended and negative impacts on consumers and tribal communities. Energy efficiency reduces consumer costs, provides energy and peak savings that are matched closely to energy needs, and provides local employment. Energy efficiency has other benefits that should be addressed in these policies, such as certainty, reliability, and insurance against heat domes and other extreme weather that can reduce some renewable resource production. Energy efficiency, along with other distributed energy resources such as batteries and demand response, can reduce the scale of renewable development needed to replace fossil fuel generation. Reducing the need for renewable resources helps avoid impacts to tribal resources associated with development of solar and wind farms and transmission lines to get their power to market. It also can reduce some large impacts to the operation of the dams and reservoirs that could hurt fish and wildlife. The WUTC should recognize the economic and environmental value of energy efficiency and distributed energy resources in offsetting the amount of renewable resources needed so the lowest-cost carbon reduction resource development path is selected. Simply increasing RPS requirements may not produce the best outcome because it does not consider whether there are lower cost carbon reduction resource strategies and strategies that better protect tribal fisheries and cultural resources. The WUTC should ensure that the evaluation of renewable resources minimizes the fish and wildlife impacts associated with integrating the electricity so it is available when it is needed.
1.6	***Topic: Puget Sound Energy should prioritize distributed solar generation:*** The costs of solar photovoltaic systems for homes and business have decreased significantly. These investments provide savings and certainty for the building owners. These systems have substantial system benefits because they do not require expanded transmission and distribution lines and thus avoid the environmental impacts of those developments. Solar systems with batteries provide storage and backup power to improve reliability. The Northwest Power and Conservation Council draft plan projects distributed solar systems will add about 1,000 megawatts of capacity and 200 average megawatts of energy by 2030. By 2045, the projection is about 5,000 megawatts of capacity and 750 average megawatts of energy. Solar roof top and battery systems will be sited behind customers' meters. In this case, line losses and ancillary services to get the power to the load are miniscule. Also, the intermittency problem of solar power is diminished somewhat, because small photovoltaic systems will be spread over wide areas of the region. Passing clouds will affect only a small portion of the installations at any moment. Thus, predictability of solar will be enhanced.

#	Summary of Comment(s)
	These policies should consider Zero Net Energy standards similar to California for new and existing houses and businesses. The evaluation of the costs and benefits of these on-site solar systems should include the savings to the transmission and distribution system discussed in detail in the draft Energy Vision Section 3.10 and Appendix E.
1.7	***Topic: Puget Sound Energy should acquire wind energy:*** The Northwest has been a leader in the adoption of wind power. Wind power is a low-cost source of power today, and it offers insurance against escalating prices in the future, because the "cost of fuel" is free. However, the intermittent production of wind power, and the difficulty in predicting when the wind will blow presents a problem with integrating wind into the system. Integration of wind is exacerbated under high-water, high-wind, and low-load scenarios. We believe that wind integration will be improved by use of various storage mechanisms discussed in the draft Energy Vision. Siting wind projects can be controversial. The Washington Energy Facility Site Evaluation Council held eight days of adjudicative hearings and took public testimony on two separate days when considering the application for the Whistling Ridge Energy Development near Underwood, Washington, and adjacent to the Columbia River Gorge National Scenic Area. Ultimately the project was abandoned by the developer. Similar concerns are now facing a wind development proposed for the Horse Heaven Hills near Washington's Tri-Cities.12 Section 3.4 of the draft Energy Vision recommends a planning process for siting renewable energy development in the Northwest.
1.8	***Topic: Puget Sound Energy should acquire solar energy:*** Solar power comes with the same integration problems that affect wind, and it comes with the same benefits of cost certainty throughout the life of the system. The capital costs of solar power have decreased significantly and there are growing opportunities to develop solar and battery systems to assist in meeting energy needs. And, as discussed in the draft Energy Vision we recommend a process for siting industrial scale solar developments that may impact undisturbed lands that are valued by wildlife or tribal cultural resources.
1.9	***Topic: Siting Renewable Resources:*** The projected growth in renewable resources could affect tribal First Foods, wildlife, and other tribal cultural resources. The Washington Department of Fish and Wildlife reports that there are currently 30 industrial solar projects proposed for Washington with a footprint of 49,000 acres, or nearly 77 square miles. Other states are facing similar development.

#	Summary of Comment(s)
	CRITFC is recommending that federal, state, and tribal governments work together on a regional plan for where renewable resources should be developed, where they should not, and to provide expeditious siting with clear and uniform standards across all political subdivisions. This effort could build on the 2013 criteria developed by the Department of the Interior for renewable resource development and the Council's Protected Areas for new hydroelectric dams. The attached draft Energy Vision has more details.
1.10	***Topic: Puget Sound Energy should prioritize acquisition of wind power in Montana near its existing transmission:*** Puget Sound Energy owns approximately 700 MW of transmission that has been providing electricity from coal plants in Montana. CRITFC recommends that PSE prioritize additional wind energy projects near these transmission lines. Additional Montana wind projects would not create additional transmission line impacts or costs and would add diversity to the wind portfolio serving the region.
1.11	***Topic: Puget Sound Energy should ensure adequate reserves to meet capacity and energy needs.*** The recommendations above should position PSE to reliably meet future electricity needs and reduce its impact on hydroelectric dam operations that kill salmon. CRITFC recommends that PSE participate in Grid West and the Northwest Power Pool Resource Adequacy Program to establish adequate reserves to meet both capacity and energy needs, especially in a low-water year. In the near term, these reserves are likely to require having combustion turbines on standby. There may be opportunities to fuel these plants with biofuels that reduce the net carbon footprint. CRITFC recommends that PSE prioritize such opportunities. Additional near-term reserves are likely to be fueled by natural gas. While CRITFC strongly supports the long-term elimination of all fossil fuels to address the climate crisis, in the near term, there may be circumstances where the choice is burning some natural gas or shutting down river operations and killing migrating salmon. This has happened in the past with devastating effects to tribal resources. Therefore, CRITFC supports rate treatment for the costs associated with maintaining, staffing, fuel contracts and fuel storage, and other costs for these resources.
James Adcock, Electrical Engineer	
2.1	***Topic: Use of historic weather data*** If PSE builds new Peakers they WILL operate off of Natural Gas, and they WILL NOT be restricted to run just to meet rare extreme peak loads. That further they WILL NOT be restricted to run just to meet PSE ratepayer needs. Rather PSE ratepayers will pay to build these plants, but they WILL run off Natural Gas, and they WILL RUN to meet Californian load – even though it is PSE ratepayers who are paying to build these plants.

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	But are these new Peaker plants even necessary? E3 finds that they are not necessary – i.e., that PSE is exaggerating their LOLP by literally 10X by using fake analysis – by using extremely cold winter day historical data from the first part of the previous century – up to 100 years before the period of analysis! [More discussion to Follow] These extremely cold winter days no longer exist. They have gone away due to Climate Change, as the following chart demonstrates:[1] Where each dot shows the coldest temperature in Fahrenheit of the coldest day of each year, and the dotted line connects the "Coldest of the Cold" temperatures in each running 20-year period corresponding to a 5% LOLP – "Once in 20 Years" calculation. PSE's modeled "Loss of Load" clearly is strongly related to such extremely cold days, which is why E3 finds that 94% of PSE's modeled "Loss of Load" occurred due weather conditions which existed in the early half of the previous century, and only 6% in more recent decades after Climate Change has made coldest winter days much more mild. One can clearly see that extremely cold days have "gone extinct" with Climate Change – "Coldest Winter Days" used to be as cold as zero degrees F., now the "Coldest Winter Days" have become a much more mild 20 degrees F. This in turn represents a reduction in "Heating Degree Load" of 20/65 – a more than 30% reduction in winter load due to cold temperatures! Yet PSE continues to use weather data even prior to 1950 – back to the early 1930s! Conversely, Hottest Summer days have become increasing hot increasingly faster, due to Climate Change:[2] PSE needs to acknowledge that Peak Capacity Shortfalls are now driven by Summer needs, not Winter needs – PSE's recent actual "emergency" shortfall conditions have happened in the Summer. And PSE needs to get rid of any continuing "Seasonal Swap" contracts – where PSE sells Summer Capacity to another utility in exchange for receiving Winter Capacity. Such "Seasonal Swaps" no longer make any sense, nor does it make any sense to build additional Peakers to continue to support such Seasonal Swaps.
2.2	***Topic: Importance of wind location diversity in modeling*** There are many ways of calculating ELCC. It is not standardized. However this paper[3] points out that correct derivation of ELCC requires correct modeling of LOLP, something that PSE clearly fails to do.

[1] See chart titled "UW/SEATAC Yearly Coldest Day Temps 1950-2020" on page 3 of the comments from James Adcock filed in Docket UE-210220 on September 14, 2021.
[2] See chart titled "UW/SEATAC Yearly Hottest Day Temps 1950-2020" on page 3 of the comments from James Adcock filed in Docket UE-210220 on September 14, 2021.
[3] M. Milligan and K. Porter. *Determining the Capacity Value of Wind: An Updated Survey of Methods and Implementation*, National Renewable Energy Laboratory and Exeter Associates, Inc. https://www.nrel.gov/docs/fy08osti/43433.pdf

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	In particular, in that paper Page 11 the authors find that ELCC should be close in value to the simple availability of Wind during periods of peak load. For example, in the not-uncommon case of Wind having 30-40% average availability, then the ELCC should be a value similar to that, but perhaps 10% lower, perhaps 27%-36% ELCC. Is this what PSE found? Not at all. Why not? In part because PSE assumes that new Wind Generation in Washington State is "perfectly correlated" to existing PSE Wind – i.e., that new Wind Generation Farms are built exactly on top of existing Wind Generation Farms. Then, if PSE has a generating shortfall, if the wind is blowing at that wind farm location, PSE already has Wind Generation happening at that existing location, in which case Existing Wind Generation *already* "Saves the Bacon", so that addition new Wind Generation – at exactly that same location – doesn't contribute much to "Saving the Bacon" – because Existing Wind Generation has *already* "Saved the Bacon"! It isn't the case that Wind makes no meaningful contribution to Peak Capacity [ELCC] but rather one can't just build all of one's Wind Farms "on top of each other" – all at the exact same location – and then assume that those new Wind Farms are going to make a meaningful ELCC contribution. Wind Diversity – of location – IS IMPORTANT – which is why Stakeholders have been pressing PSE for many years to seriously explore Wind in Montana.
2.3	***Topic: Batteries and pumped storage*** PSE's modeled findings that Batteries do not make a meaningful contribution to ELCC doesn't make any sense to me. At least SOME amount of batteries should contribute to "peak shaving" and "valley filling" leading to reduce LOLP. The notion that whenever PSE has a shortfall that shortfall always exists continuously for multiple days at a time is simply false. Almost always there are going to be "off peak" hours during which PSE can recharge batteries, and almost always peak conditions are going to last four hours or less, in which case four-hour batteries can make a meaningful contribution. The following chart from BPA,[4] which shows Californian Exports/Imports [from Mid-C] during a recent *Rare* cold snap shows these patterns. Positive numbers represent Exports from the PNW to California. Negative numbers represent *Rare* imports from California to the PNW – a condition which almost never exists – 99% of the time "we" – the Pacific Northwest – are exporting power to California – huge amounts of power, averaging 7000-9000 Megawatts. IE the PNW almost always has huge excesses of power! This plot demonstrates the *extreme rare* opposite to the rule – where the PNW is importing a few thousand Megawatts from California. And in turn the first couple days of the year do show *the rare condition* where power was being imported continuously from California. Even on this rare very-cold month all the other days show the typical daily pattern of fluctuation – with twice daily peaks of capacity need in the morning and early evening – a daily pattern of fluctuation where Batteries can indeed in reality contribute to ELCC by (as previously suggested) being used to shave peaks and fill valleys. And

[4] See chart titled "AC+DC Interties: 15-min averages" on page 7 of the comments from James Adcock filed in Docket UE-210220 on September 14, 2021.

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	as is well-known in the Electrical Utility business, smoothing out load in this manner is extremely effective in using existing resources – including Transmission – more effectively. Which in turn is why Commercial and Industrial customers have traditionally been charged a large premium based on their patterns of peak usage. In summary, batteries *do* make a meaningful contribution to ELCC *except* during those extremely rare periods of time when energy is being imported *continuously* for several days from California. In addition, this plot shows the falsity of assumed limitations on imports into the PNW, where PSE has adopted NW Council/RAAC false assumptions of very limited availability of imports. On the contrary, California has huge excess generating capacity in the winter available for import to the PNW, as this plot shows, where 2500 Megawatts are being imported from California – no muss no fuss – contrary to the NW Council/RAAC / PSE assumptions of limited availability of imports to the PNW. Comments for Batteries are equally applicable to Pumped Storage. Pumped Storage even has the potential ability of more hours of peak shaving and valley filling.
2.4	***Topic: Hydro integration*** Similar to Batteries or Pumped Storage, Hydro Operations (primarily BPA) has the ability to generate "Synthetic Storage" by modulating existing Hydro Flow. Examples of this already being performed are called "Wind Integrations" or "Solar Integration." Also Hydro natural largely automatically modulations production to "get out of the way" of Wind and Solar generation for a very simple reason: It is not profitable for BPA to generate during periods of high Wind and Solar, so it is better for BPA (if possible) to store water behind their dams during such periods, and use that water later. Choosing to use water later is called "Energy Storage" and effectively performs the same function as Battery Storage or Pumped Storage. PSE should be exploring ALL POSSIBLE contracts with BPA for Hydro Power in all forms of contracts, including "Wind Integration" and "Solar Integration" as well as all other forms of hydro power tranches.
2.5	***Topic: Stakeholder Engagement*** The first thing to note is that PSE *did* [in general] answer E3's questions and *did* provide E3 with support. This is in sharp contrast to how PSE has been treating its IRP/RFP/CEIP stakeholders, where PSE *does not* meaningfully answer our questions and *does not* provide meaningful support. Examples of this include: I "raise my hand" at PSE meetings and PSE simply refuses to acknowledge my raised hand. I asked PSE where in Washington their Wind Data corresponds to – choice of location may result in Wind Availability varying from 30% to 40% -- and PSE's answer was to point me at 1 Terabyte of Federal Wind Data corresponding to the entire United States and say "Go Fish" – i.e. "You try to figure out what data we might

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	have used." I suggest that this stonewalling behaviour on the part of PSE indicates that there are indeed problems with PSE's choice of Wind Data location. And at the same time PSE represented to UTC Staff and Stakeholders that PSE had answered my question. No they hadn't, actually. In addition over the years PSE has acted to explicitly try to exclude me from public participation, and at other times has merely suggested that I should no longer publicly participate. I ask that UTC make it clear that such efforts to "pick and choose" who belongs or doesn't belong in the public participation process are inappropriate – of course given the choice PSE would choose stakeholders who are less critical of their actions!
2.6	***Topic: Provides an interpretation of the results of the E3 report*** Page 7 of E3's presentation: E3 strongly disagrees with PSE's modeling of Batteries in regards to Mid-C. E3 strongly disagrees with PSE's modeling of Battery Characteristics. E3 disagrees with PSE's modeling of correlations between resources. E3 disagrees with PSE's use of ancient weather data [In comparison I *strongly* disagree with PSE's use of ancient weather data since by E3's own analysis it inflates PSE LOLP by literally 10X] E3 disagrees with PSE's modeling of Hydro Data. [Hydro generation is generally displaced by Wind and Solar, resulting in more stored water behind the dams which can be used to generate addition power in the hours and days in the future.] Even E3 has not received enough information from PSE to be able to evaluate whether PSE's modeling of Battery Dispatch is sensible or not. [The great value of Batteries is that they need not only be used for one purpose (say peak shaving) but can also be used for other purposes, such as short-term dynamic load balancing +/-, and to help fill in sudden power shortages, such as a sudden loss of wind, loss of a Coal or Natural Gas plant, or afternoon "Duck Curve" rapid ramp rates.] I do not believe PSE correctly modeled all the possible usages, and the financial contribution Batteries would make when used in these manners. Page 10: E3 points out how contrary to industry standards PSE is understating Battery storage capacity.

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	Page 11: E3 points out that PSE does not correctly model correlations between weather and renewables. Page 12: E3 points out that 94% of PSE's modeled Loss of Load correspond to weather conditions which existed prior to 1972 – more than 50 years ago [the first half of PSE's weather data used in modeling] – and only 6% of PSE's modeled Loss of Load correspond to weather conditions which exist since 1972 [the more recent half of PSE's weather data used in modeling] IE if even weather data just corresponding to the most recent 50 years were to be used in PSE's modeling efforts, then PSE's Loss of Load would only be 12% of what PSE is currently claiming [due to PSE's use of extremely old weather data.] If PSE's use of weather data were to be further reduced, even to say generously use the most recent 40 years of weather data, then PSE's modeled Loss of Load would be further reduced to only about 10% of PSE's currently modeled Loss of Load! It is high time that UTC stops this PSE modeling nonsense! UTC *must* direct PSE to stop using weather data more than 40 years old! Does UTC want PSE to make reasonable modeling efforts that fairly informs what PSE builds or buys -- or not? PSE current continued use of ancient weather data *does not* reasonably inform what PSE needs to build or buy! Page 13: E3 points out that PSE incorrectly models Hydro as a completely inflexible source of power that does not perform [explicitly or implicitly] any "integration" [i.e. "accommodation"] of Renewables. We know this is not true. BPA through their publicly available Operations Data clearly shows the Hydro operations *DO* modulate to "accommodate" Renewable – when Wind or Solar generate then Hydro "automatically" reduces its generation to accommodate those "cheaper" resources – i.e. Wind and Solar are at the bottom of the dispatch stack, they are the cheapest resources, they are "must run" resources, so all other resources, including Natural Gas and Hydro "get out of their way" – because Natural Gas and Hydro are higher [more marginal] on the dispatch stack. As is well known – because we have all heard BPA scream – in the spring time there can be *brief* periods of time when more Wind, Solar, and Hydro all want to run than Load to consume that desire – because running Hydro is less damaging to fish than spilling Hydro, and then much to BPA's chagrin they have to pay renewables to not run. All other times BPA Hydro *can* accommodate Wind and Solar, does "get out of their way" without Spilling, i.e. storing that water as Energy Storage [just like Batteries or Pumped Hydro] to be used when needed in a future hour or a future day. Water behind a Hydro Dam IS ENERGY STORAGE! Page 14: E3 points out that in only 2% of PSE's modeled cases do the modeled Batteries even do *anything*! IE PSE's "model" of battery use is that they have these batteries sitting around DOING NOTHING! This is clearly false modeling. Reasonable modeling would show that almost 100% of modeled days Batteries ARE "doing something" – peak shaving, valley filling, load balancing, duck curve ramp rate limiting, short-term filling of sudden loss of Wind Power, or sudden tripping off-line of Coal or NG resources, etc. Page 16: Additional Problems E3 Finds: PSE consistently finds lower ELCCs than other utilities. PSE makes

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	questionable operating data assumptions. PSE makes questionable load shape assumptions. PSE makes unreasonable limitations on Pumped Hydro storage utilization. PSE makes unreasonable limitations on “Hybrid” Renewable + Battery operations. PSE makes unreasonable limitations on the assumption of PNW regional imports from Mid-C [“market availability”] PSE makes unreasonable limitations on the assumption of off-hour regional imports to Mid-C – which could be used to recharge Batteries or Pumped Hydro. PSE makes unreasonable limitations on the assumption of available transmission [AC+DC transmission line capacity] from California to PNW [South-to-North direction] PSE unreasonably assumes two-hour Battery capacity rather than industry-standard four-hour Battery capacity. PSE unreasonably assumes that Batteries cannot be fully discharged, as compared to the industry-standard assumption that Batteries can be fully discharged. PSE without explanation just suddenly reduced the assumed ELCC of storage technologies. What? If PSE doesn’t like an answer, then PSE just suddenly changes it without explanation? This isn’t “modeling” – rather it is “marketing” masquerading as “modeling”! Page 17: E3 asks that PSE fixes how they model regional additions in the context of ELCC calculations. E3 asks that PSE follow industry standards about how they model Battery storage capacity, rather than making up their own special PSE-specific rules. E3 asks that PSE fix their modeling to correctly model correlations between Weather and Wind and Solar E3 asks that PSE fix their modeling to correctly model future Weather data, rather than relying on ancient weather data. E3 asks that PSE fix their modeling to correctly model the fact that Hydro is a dispatchable, not a fixed resource – which can generally well-integrate with Wind and Solar, to the benefit of all. In summary, if one strips away the “Consultant Niceties” of what E3 is saying – E3 is basically saying that PSE’s modeling efforts are a disaster! And do not accurately reflect what capacity additions nor what technology is should be used for those additions. PSE’s modeling effort have been a disaster for more than a decade now. UTC needs to step in to fix this problem before CEIP is defeated by PSE’s nonsensical modeling! Start by directing PSE to stop using weather data

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	more than 40 years old. Require PSE to fix these innumerous problems and rerun their modeling effort BEFORE purchasing any new Peaker capacity. Conversely we know from PSE prior IRP cycles that in current CEIP conditions -- previously known as the "Green World" scenario -- PSE need to purchase tremendous quantities of new additional Wind Power. GET ON WITH IT! Build or Buy that Wind Power NOW and Stop Making Excuses!
JSR Capital	
3.1	***Topic: Impact of climate change on temperature and loads, and timing of updates to data in planning and resource acquisition analysis*** • CETA (and WA State) recognizes that climate change will affect PSE loads, and using the past 88 years (through 2016) as representative of temperatures and loads is not appropriate for the next 20-40 years and the PSE Phase 2 process as it was initially envisioned; • Heating Degree Days ("HDD") are rapidly decreasing, Cooling Degree Days ("CDD") are increasing and PSE is transforming, similar to Portland General, and becoming a dual peaking utility in the near future, due to climate change; In the October 8th E3 ELCC report on page 59, "E3 recommends that PSE reevaluate the appropriateness of its current approach to considering temperatures in developing load shapes." However, they leave that for a future IRP without adequate justification. The E3 analysis is based on year average values and the impact on peak winter conditions versus evaluating both peak summer as well as peak winter conditions and loads. Table 10 of the document shows a profound difference in ELCC values for Lund Hill solar of 30.3% to 54.3% using temperature data (2027 and 2031 respectively) versus 8.3-7.5% using PSE base case numbers. While generic eastern WA wind decreases in ELCC value from 17.8% (base case) to 7.8% (temperature case) in 2027. Therefore, without taking changing temperatures into account in this RFP process and modifying the summer and winter load shapes due to climate change, PSE will be designing a portfolio to better suit the past 88 years versus the future that WUTC has requested. Commissioner Rendahl stated that the Utility [PSE] should be building a utility for the future and not for the past. • For resource planning, it may be appropriate to wait for the next IRP to reevaluate temperatures, load shape, and the resulting impact on ELCC. However, for the purpose of the All-Source 2021 RFP Phase 2 evaluation process, waiting is not a prudent decision. Based on its Phase 2 evaluation, PSE will be making resource decisions that will impose additional costs on PSE's customers. PSE is obligated to select resources that are lowest reasonable cost and to make that determination they must utilize the most-recent information available to them. • Climate change is exponentially occurring based on United Nations data, Union of Concerned Scientist reports and other sources.

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	• PSE indicated to WUTC that there was sufficient time to readjust its portfolio decisions in the upcoming RFP Resource Acquisition Phase 2 analysis and PSE should not wait to incorporate the Temperature Sensitivity analyses for the 2022 IRP. Using temperature data for ELCC summer values and appropriately modifying the load shapes is an essential part of that process. At a minimum, the ELCC temperature values as detailed in Table 10 should be used as the base case in the revised PSE modeling for the portfolio determination of Phase 2. • ELCC values should be differentiated between summer and winter and a single value for the year is not reflective of either the best winter or the best summer resources to meet PSE's peak loads and LOLP. Specifically, a 4% ELCC, which was the PSE IRP base line value going-in for eastern WA PV solar as a single ELCC year average value, is not reflective of climate change's impact to PSE, coincidental summer benefits, or expected summer loads over the next 20-40 years which is the expected service life of an Eastern WA solar asset.
Northwest & Intermountain Power Producers Coalition ("NIPPC")	
4.1	***Topic: ELCC values from PSE's temperature sensitivity vs. the base scenario for solar, solar-plus-storage, and stand-alone storage resources*** NIPPC notes that the ELCC values from PSE's "temperature sensitivity" for some solar resources in 2031 are more than ten times larger in 2031 than the base scenario for those same resources. Similarly, the ELCC values from PSE's "temperature sensitivity" for solar-plus-storage and stand-alone storage resources in 2031 are at least two to three times larger in 2031 than the base scenario for those resources. This large discrepancy between the modeled ELCC values suggests that it would be a mistake to stay committed to an unadjusted base scenario for all the modeled resources. PSE should propose and adopt an alternative base value for the solar, solar-plus-storage, and stand-alone storage resources whose numbers appear to be incorrect.
4.2	***Topic: Climate change impacts on loads and weather, and use of historic weather data*** Fundamentally, NIPPC is concerned that PSE's proposed ELCC values fail to adequately account for its present and future needs, particularly considering the anticipated changes (and risks) associated with climate change and the resulting seasonal shifts in load. The Clean Energy Transformation Act ("CETA") recognizes that "Washington must address the impacts of climate change," and electric utilities must take action to address and plan for a transformed electricity system. PSE's RFP relies upon 88 years of historic weather data without appropriately adjusting for the future climate. This baseline is not representative of the next 20-40 years, during the useful life of assets procured in PSE's RFP.
4.3	***Topic: Changing winter and summer peaks, importance of using ELCC values reflecting of changing needs*** PSE's system is changing. Heating Degree Days are decreasing, and Cooling Degree Days are increasing. PSE should recognize that its system may be transforming into a dual peaking system. Given this, the proposed base annual ELCC values for some resources might not be reflective of PSE's future system

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	needs. Instead, in addition to an alternative base ELCC value for some resources, the ELCC values in PSE's RFP should be differentiated between summer and winter to account for the potential seasonal load changes.
4.4	***Topic: Recommendations for solar, solar-plus-storage and stand-alone storage resources*** In light of the above, NIPPC suggests that the Itron calculated ELCC values for solar, solar-plus-storage, and stand-alone storage resources should be used as the baseline ELCC values rather than solely for a sensitivity analysis. NIPPC does not recommend changes to any other ELCC values at this time.
Plus Power	
5.1	***Topic: ELCC of batteries (BESS or energy storage)*** There appears to be no movement in the projected ELCC values for BESS facilities that was reflected in the ELCC Workshop materials and appears to have been questioned by E3 as not being in alignment with industry standards in their initial materials. E3's ELCC Study whereby E3 states PSE's assumptions are generally reasonable while further following with the recommendation of a number of additional studies leaves much to be desired from the perspective of a developer and participant in this process. Plus Power agrees with E3's determination that PSE should run additional modeling assuming regional capacity standards are met across the planning horizon, such that Energy Storage ELCC value is not unfairly disadvantaged in the portfolio evaluation. To reiterate, PSE's ELCC value for Li-ion 4-hour BESS of 24.8% is far below industry standards, including its neighboring utility, Portland General Electric ("PGE") as noted in previously filed comments. While the divergence of ELCC valuation between the utilities does not appear to have been directly addressed in a quantitative manner at this time, Plus Power recognizes the locational value of resources to each respective utility. As discussed on Page 29 of PSE's ELCC Workshop Presentation, Energy Storage located in a load pocket should be afforded a higher ELCC value due to location. However, the manner in which higher value would be assigned has not been quantified for bidders. Although Plus Power recognizes that the ELCC of a particular resource is unique to each utility and it would be impossible to directly compare PGE and PSE's results, it remains a relative mystery how utilities with similar seasonal load profiles would end up assessing standalone energy storage resources so differently. Plus Power would appreciate greater transparency into the main drivers and assumptions for PSE's 24.8% ELCC valuation of 4-hour storage, and to better understand where the model diverges from PGE's result of 60.0 - 85.0% ELCC for the same 4-hour duration asset class. The lack of clarification addressing previously filed comments is also concerning regarding the significant divergence of ELCC value for BESS when compared to PSE's 2017 IRP, which assigned a 4-hour Li-ion storage facility an ELCC value of 88%.

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5.2	***Topic: Discussion of ELCC for variable energy resources*** In recent stakeholder presentations, PSE staff has expressed the desire to contract and own resources closer to its load centers for reliability purposes, and to decrease those procured out of the short-term market or via long-distance firm transmission. However, the methodology to be used during the evaluation of RFP submissions to assign added locational value to resources has not been made available. With that in mind, Plus Power wishes to address the apparent inconsistency between ELCC for storage and VERs owned or under contract to PSE. For example, the Golden Hills Wind Farm under contract to PSE is assigned an ELCC value of 60.5% for the 2027 planning period. This wind farm is not yet in operation and will be delivered to PSE's system via firm transmission from the BPA John Day substation in Oregon, east of the Cascade Mountains. This stands in stark contrast to PSE's assumptions on page 17 of the Resource Adequacy and ELCC Primer, where PSE notes VERs are non-firm resources that cannot guarantee firm supply during peaking events, and thus will not be granted any capacity credit (referring to Mid-C delivered resources). PSE further adds that cold-weather and summer events in recent years took place where 5 MW and 61 MW, respectively, out of an 800 MW portfolio of wind resources was deliverable to load or operating. Plus Power struggles to reconcile a 60.5% ELCC value for a distant wind project while being unable to deliver any firm capacity supply as a VER per PSE's characterization in contrast to such a low ELCC value for a dispatchable resource such as Energy Storage located within a load pocket.
5.3	***Topic: Understanding the full capability and value of stand-alone storage*** As stand-alone Energy Storage resources are charged directly from the transmission grid are not co-located with renewable generators, they possess the ability to charge and discharge fully unconstrained. Dispatch can be driven directly from utility system needs and scheduled to optimize utility benefits from the resource, including meeting peak demand hours and other reliability needs such as ancillary services. As noted by E3 on Page 10 of the ELCC Workshop Presentation, PSE's application of the minimum state of charge ("SOC") and one-way efficiency reduces the maximum and overall ELCC results for battery storage resources. It is further noted that PSE is currently utilizing a minimum SOC of 20%, which does not align with minimum storage limits in PSE's own HDR report. E3 correctly assumes that most RFP bidders will design their projects such that the entire capacity would be provided for discharge purposes, and thus not improperly impairing ELCC valuation for Energy Storage. Constraints on the charging and discharging limitations of a stand-alone energy storage resource should be considered purely from a system perspective, and not based on limitations of charging and discharging to meet minimum ITC / PTC thresholds, or from vague assumptions restricting charging capabilities when there are undefined "system outages".

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Public Counsel	
6.1	***Topic: Public Counsel recommends that the Commission encourage PSE to implement the recommendations from E3 in their October 8, 2021, report on PSE's energy effective load carrying capability methodology.*** E3's report, filed October 8, 2021, concludes that PSE's approach to the ELCC is reasonable and makes six total recommendations to PSE. E3 recommends that prior to conducting their portfolio analysis in the current RFP, PSE should: 1) Conduct an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP standard before recalculating ELCC; 2) Restate ELCC values for battery storage in a manner more aligned with industry standards, such that storage can discharge at maximum capacity for X hours if the storage is defined as having X hours of duration, and align the presentation of ELCC values with the characterization of minimum, maximum, and nameplate MW values in RFP documentation; and 3) Re-calculate battery storage ELCCs under the assumption that PSE's treatment of its own Contingency Reserves and the NWPP's Reserve Sharing Program is the same as in PSE's Base Case without battery storage, and investigate the significance of the revised results. Regarding future IRP cycles, E3 recommended that PSE should: 1) Utilize weather-matched load that is aligned with wind and solar data; 2) Reevaluate its current approach to considering temperatures in developing load shapes based on (1) the use of two different weather stations, and (2) the changing climate; 3) Update modeling to incorporate hydro dispatch capabilities and hydro energy limitations. Public Counsel attended the ELCC workshop and reviewed E3's subsequent report. We appreciate the efforts of the Company to provide information and education about its methodology. We also value the opportunity to review the E3 report and their recommendations. As the report acknowledges, this is a complicated subject with no single national standard or method for determining resource adequacy. There are a number of important issues that are interacting in this case, including the role of the Mid-C market, the dependence of the Pacific Northwest on hydropower, and the changing climate. Public Counsel believes that the recommendations made by E3 with regard to the RFP and future IRP cycles are reasonable and address a number of concerns held by stakeholders. We believe the Commission should encourage the Company to implement these recommendations, which should provide additional confidence in PSE's methodology.

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NW Energy Coalition, Renewable Northwest and Rye Development	
7.1	***Topic: Treatment of market availability in ELCC modeling methodology*** In their review, E3 looked at the model input, outputs and assumptions which were key to inform PSE's ELCC values. Based on their review, E3 pointed out several methodological concerns or flaws that were apparent based on prudent utility practices in the region and across the United States. E3 found that PSE's treatment of the Mid-Columbia ("Mid-C") market's capacity undervalues both short- and long-duration storage resources because it underestimates the capacity available and being procured in the region. This underestimation inaccurately reflects a market that is short on energy during particular hours of the day when, in reality, recent analysis from the Northwest Power and Conservation Council ("NWPCC") for their 2021 Northwest Power Plan shows that the region has enough capacity to ensure a reliable and adequate supply for the year 2025. In our previous comments and related technical memo, we highlighted a similar issue in which PSE's treatment of Mid-C's availability is artificially constraining the system and causing an energy shortfall, consequently preventing battery and pumped hydro storage facilities from being able to charge prior to peak load hours. This is causing the extremely low ELCC values coming out of PSE's RAM modeling which, in turn, would have negative consequences for the Company's resource acquisition, leading to neither a cost-effective nor a reliable supply for PSE's customers. In our previous comments, we pointed out that the reduction in availability of market purchases in PSE's IRP may be artificially constraining the ability of storage resources (including battery and pumped hydro storage) to meet PSE's capacity needs. By revising assumptions to reduce the availability of market purchases across the board, the GENESYS model artificially imposes a significant market import limitation across the full 24-hour window on all days in January and February instead of only during "super-peak" and "heavy-load" hours. As a result, PSE's modeling suggests there may be insufficient energy to charge storage resources even though PSE has not presented analysis to support this lack of available energy in low loss-of-load hours. In other words, the IRP's modeling assumption does not appear to reflect expected system conditions. Rather, it creates artificial conditions where storage resources do not have enough energy to charge during off-peak hours, thereby reducing their capacity contribution and availability to dispatch when PSE's needs are the highest. In their recommendations, E3 note that "[t]o assess the impact of changes in PSE's approach to Mid-C on ELCC values, E3 recommends an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP standard before recalculating ELCC." E3 points out that "adding capacity to the region would increase the reliability of the Mid-C resource but would also reduce the need for reliability-driven capacity additions to PSE's system." E3 in their review of PSE's ELCC modeling methodology also point out that "[f]ailure to consider the availability of surplus energy in the regional market would result in over-procurement and higher costs for PSE ratepayers. It is reasonable for PSE to assume that some amount of energy would be available in the market

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	due to the nature of the region's hydroelectric resource base, which produces surplus energy during most years. PSE must therefore strike a careful balance between the potential reliability implications and cost savings associated with reliance on the regional market." The concerning aspect of PSE's treatment of Mid-C availability lies in the fact that PSE does not model the assumption that reliability-driven capacity additions are made to the broader Pacific Northwest region to achieve a reliability standard. Instead, it relies on outdated model (NPCC's GENESYS) cases which portray that regional system's reliability degrades below accepted resource adequacy thresholds as load continues to grow and plants retire. This is not a prudent observation because NPCC's recent adequacy analysis, as well as active large-scale procurement of capacity resources, shows that the region is procuring enough capacity resources to stay below the Council's 5% LOLP threshold even under an early coal retirement scenario. We also note that there are some inconsistencies in E3's report related to their review of the impact of potential additions to the regional capacity by replacing 500 MW of perfect capacity with 500 MW of Mid-C capacity. A close review of Figures 2 and 3 reveal inconsistencies in the reported unserved energy in the plots and inconsistencies between the data in the plots and their textual interpretation. Without additional clarification, it is difficult to discern whether E3's analysis adequately investigates the potential sensitivity of PSE's modeling to Mid-C availability and reiterates the importance of PSE conducting additional analysis on this topic. ***Recommendations:*** PSE conducts additional GENESYS model runs assuming a regionally adequate system and folds in that analysis to recalculate the ELCC values of short and long-duration storage resources. PSE consults with E3, to clarify and correct the errors mentioned in our comments relating to E3's review of PSE's treatment of Mid-C output.
7.2	***Topic: Question about whether energy storage resources have access to energy delivered by perfect capacity resources for charging in model*** While not addressed in the report, PSE's presentation on the calculation of energy storage ELCCs raised an additional question regarding their methodology. PSE claims that they are calculating a last-in ELCC for energy storage by adding energy storage after perfect capacity. However, PSE has not clarified whether the energy storage dispatch algorithm is able to see and access energy from the added perfect capacity resource for the purposes of storage charging. If energy storage resources *do not* have access to the energy delivered by the perfect capacity resource for charging, then the perfect capacity added has no effect on the storage ELCCs which causes further degradation to their value, which should be remedied.

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	Recommendation: We request that PSE clarify this point with regard to the IRP modeling and ensure in the RFP modeling that the energy storage dispatch algorithm is able to rely upon other added resources, including any added perfect capacity, to charge.
7.3	***Topic: Limits placed on State of Charge of battery storage resources*** In the report, E3 also points out that there are artificial limits placed on the State of Charge (SoC) of battery storage resources, contrary to their own consultant's report on standard utility practices. Folding in a Minimum SoC requirement has a rollover effect on battery storage ELCC values because of a limitation in their charge and discharge, causing inefficiencies for the PSE system. ***Recommendation:*** We agree with E3's recommendation that PSE should restate its ELCC values for battery storage in a manner more aligned with industry standards and align the presentation of ELCC values with the characterization of minimum, maximum, and nameplate MW values in its RFP documentation. We hope that PSE will change these artificial limits based on technical characteristics of the bids they receive for the RFP.
7.4	***Topic: Use of outdated weather and temperature data sets*** PSE's use of outdated weather and temperature datasets in light of severe climate change is concerning because it relies on data going back to 1929 to inform its resource planning and procurement in 2021. This is leading to a situation in which the outage events in PSE's modeling are not evenly distributed across temperature input years -- 33% and 35% of simulated draws with loss-of-load events in January 2027 and January 2031, respectively, occur with load data prior to 1948. Further, 94% of simulated draws with loss-of-load events in January 2027 and January 2031 occur with load data prior to 1972, the midpoint of the temperature year data. Using outdated weather and temperature datasets in light of climate change runs the risk of skewing the Company's analysis and leading to imprudent procurement decisions. ***Recommendation:*** We recommend PSE run additional ELCC and loss-of-load studies based on datasets from 1980 onwards to ensure that the effects of climate change on load and temperatures are clearly analyzed and evaluated.
7.5	***Topic: RFP approach to evaluating Phase 1 resources with 2021 IRP generic ELCC values vs. updated values.*** PSE has stated that they intend to make ELCC methodological updates in Phase 2 of the RFP, but that they will continue to rely on generic ELCC assumptions from the IRP to screen resources in Phase 1 of the RFP. This approach could lead to poor procurement decisions if resources are screened out in Phase 1 that would otherwise have contributed to stronger portfolio performance in Phase 2. PSE has asserted that the ELCC methodology does not need to be updated in Phase 1 because resource comparisons in Phase 1 are only made between technologically similar resources. However the validity of this assertion cannot be

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	confirmed without additional transparency into how methodological updates affect storage ELCCs and whether the generic storage ELCCs from the IRP represent reasonable proxy values for a wide range of potential storage configurations with different round-trip losses, minimum and maximum storage levels, and other key parameters. In addition to the methodological updates that we recommend in these comments, we also recommend that PSE be required to demonstrate that screening decisions made in Phase 1 are robust to any implemented ELCC methodological updates in Phase 2. In the event that the ELCC methodological updates materially affect the performance of any storage resource that was screened out in Phase 1 such that it could reasonably compete with resources (of any technological type) that were taken to Phase 2, that storage resource should be advanced to Phase 2 for full evaluation. ***Recommendation:*** PSE demonstrates that screening decisions made in Phase 1 are robust to any implemented methodological updates in Phase 2 to avoid exclusion of cost-effective capacity resources in Phase 1 of the RFP.
Renewable Energy Group (Gray's Harbor Facility, biodiesel)	
8.1	***Topic: Comments support ELCCs and advocate biodiesel for Washington*** REG believes PSE's analysis appears reasonable given the unique regional generation mix and reveals the right fit for their customers. Biodiesel powered generation offers an excellent solution for providing infrequent but long-duration peaking capacity. Recent extreme and cold weather in Texas and Europe demonstrate the need to prepare for all possible scenarios despite a warming climate. The proposals that REG supported show that thousands of megawatt-hours can be stored in the form of biodiesel onsite with a minimal footprint, low GHG emissions, and at low cost. If even longer duration is required, fuel can be easily refilled given the significant amount of local production capacity and the logistics present to ensure timely delivery. Biodiesel is renewable, biodegradable, non-toxic, and because it is an oxygenated fuel combusts more thoroughly than conventional petroleum diesel. It is comparable in transporting and handling to vegetable oil and as mentioned before, reduces Scope 1 emissions by at least 94% from fossil diesel. Utilizing this energy dense, low cost, storable, and clean emitting fuel for peak power demand is the best choice to power Washington.
Rye Development (Swan Lake and Goldendale, pumped storage hydro)	
9.1	***Topic: PSE's response to a joint letter from NW Energy Coaliton, Renewable Northwest and Rye Development submitted to PSE on July 14, 2021*** PSE responded to this letter on August 19, 2021 (the "Reply Letter"), and Swan Lake and Goldendale were encouraged and appreciative of PSE's thoughtful reply. The letter from Josh Jacobs, Vice President of Clean Energy Strategy highlighted PSE's adjusted approach to its RAM specific to storage resources that are outside of PSE's network. Swan Lake and Goldendale greatly appreciate PSE's willingness to entertain changes to its RAM. In the Reply Letter, PSE indicated that:

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	There could be simulations in the RAM where the region has adequate supply (meaning the 1500 MW of transmission to short-term market imports are full), but PSE's system is short during some hours. Remotely-located energy storage systems could be charged during those hours, even though PSE's system is short. Hours when there are shortages in the region would impair the ability to charge these remote storage resources, not shortages on PSE's system. These are issues PSE will be exploring further in our analysis at the upcoming Resource Adequacy ("RA") workshop on August 31. Additionally, the RA workshop will include analysis performed by a third-party consultant that was hired by PSE working through PSE's Independent Evaluator. Given the above statements and commitments by PSE in its Reply Letter, Swan Lake and Goldendale respectfully request an update on when parties in this proceeding should see simulation updates for remotely-located storage resources. Similarly, Swan Lake and Goldendale request further information from PSE and the Commission on how these ELCC updates will be used in evaluating the 2021 RFP bids. As with the E3 ELCC modeling recommendations (discussed in further detail below), Swan Lake and Goldendale would like some clarity on whether these new simulations will create a window for RFP respondents to amend pieces of their already-submitted proposals. Swan Lake and Goldendale strongly support allowing RFP respondents to update their proposals based on this more accurate information. If RFP respondents are able to amend pieces of proposals, Swan Lake and Goldendale request further information from PSE and/or the Commission on whether this amendment opportunity would follow the same timeline as the Customer Benefit Plan/Clean Energy Implementation Plan revision window, or if it would come later, in Phase II of the RFP process. In either case, Swan Lake and Goldendale urge PSE and the Commission to allow RFP respondents an ability to revise and update their proposals to reflect the most accurate and current modeling results and information. Absent providing this opportunity, the significant effort undertaken by PSE, stakeholders, E3, and others to assess the accuracy of PSE's modeling efforts would largely be academic in nature, yielding no tangible impact on whether PSE is acquiring the set of resources that are the least cost and in the best interests of PSE's customers.
9.2	***Topic: Supports E3 recommendation to conduct an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP*** In E3's report, E3 recommends that PSE "conduct an additional GENESYS model run assuming regional capacity additions such that the region meets a 5% LOLP standard before recalculating ELCC." Swan Lake and Goldendale strongly support this recommendation and request that PSE run the additional GENESYS studies recommended by E3, including publishing the updated ELCC results, before Phase II of the RFP. In addition to publishing these updated studies and ELCC values before Phase II of the RFP, Swan Lake and Goldendale request that PSE provide an explanation and justification for using (or not using) the re-calculated ELCC results in Phase II of the RFP.

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9.3	***Topic: Impact of updated ELCC values and model runs on RFP process*** In addition to requesting that PSE re-run its GENESYS model in accordance with the recommendations of its own consultant, Swan Lake and Goldendale also have remaining concerns about how any updated ELCC values and model runs will impact the RFP process. Namely, it is unclear if respondents to the RFP (like Swan Lake and Goldendale) will be able to re-submit or edit pieces of their proposals that may be impacted by any adjustment to PSE's modeling. Given the potential for these modeling adjustments to significantly impact the ELCC values of storage resources, Swan Lake and Goldendale strongly support allowing a re-opening of bids to adjust pricing and assumptions as a result of more accurate ELCC modeling results.
9.4	***Topic: Joint comments submitted separately with NW Energy Coalition and Renewable Northwest*** Finally, Swan Lake and Goldendale are also signatories to comments being submitted in this proceeding jointly with NWEC and RNW.4 Without repeating those comments here, Swan Lake and Goldendale would just note that those comments identify several additional, outstanding concerns with respect to PSE's ELCC modeling. In particular, those comments note that several of the issues previously raised by Swan Lake and Goldendale regarding PSE's ELCC modeling remain outstanding concerns in this proceeding, and many of these same concerns were identified in E3's report. For example, E3 shares Swan Lake and Goldendale's concerns regarding: (1) inability of storage resources to properly charge using market energy; (2) PSE's flawed assumptions regarding Mid-C market capacity availability; and (3) PSE's reliance on outdated temperature and weather datasets that are not adjusted for more recent climate change events, which results in skewed loss of load events and inaccurate ELCC values.
Tom Dechert, resident Clarkston, Washington	
10.1	***Topic: Advocates cessation of rebate programs encouraging customers to switch from electric to gas*** To be succinct, I suggest that the AGENCY [referring to WUTC] immediately stop approval for any and all rebate programs which encourage rate payers to install gas fired furnaces or other appliances in homes or businesses. I suggest that this action should be taken immediately by all regulated utilities. It makes no sense whatsoever when we are all trying to reduce our carbon footprint in response to global warming to have regulated utilities continuing to offer financial encouragement to individuals and businesses to increase the use of natural gas.

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	If individuals or businesses decide to convert to natural gas, that of course is still their decision. But the AGENCY should stop encouraging or allowing the utilities to encourage such action through rebates.
Washington Clean Energy Coalition, Sierra Club and 13 other environmental advocate groups	
11.1	***Topic: Warming weather trends*** Our region's climate is changing. Winters and summers in the Puget Sound are getting warmer. But PSE's modeling methodology is not sensitive to the data of the last 30 years, which demonstrates these clear trends. Instead, PSE uses random sampling from the past 88 years of temperature data and the past 80 years of hydro data. The combinations of these randomly selected data are intended to provide a realistic model of the future. If the lights stay on in 95 percent of these scenarios, PSE assumes everything will be all right. There are many signs that PSE's methods are failing. For example, the independent consultant, E3, found that 94% of the random scenarios that caused a "Loss of Load" came from data samples collected prior to 1972. We surmise that most of these problematic scenarios occurred in winter due to projected cold temperature. But winters were colder in years before 1972 than they have been in more recent decades. PSE is on track to build a system that would work in the 1930s, not the 2030s.[5] The solid lines in these graphs chart the coldest and hottest temperatures for each year. These extreme temperatures drive peak demand and PSE's peak capacity needs. The shaded areas show the range of cold or hot temperatures for each 20-year period, starting in 1932. The dotted lines show a rising average trend over the 90-year period; the dashed lines show the coldest or hottest temperatures for each 20-year period. We see that lowest and highest temperatures are rising more rapidly than the average trend. It is these "coldest of the cold" and "hottest of the hot" temperature extremes that pose the greatest risk of power adequacy shortfalls and service outages. Although PSE's modeling is missing the risks and opportunities implied by shifts in seasonal extreme temperatures, the company acknowledges that demand is declining in winter and rising in summer. However, PSE appears to dismiss the possibility that it may become a summer peaking utility within the next decade. E3, the independent consultant on resource adequacy issues, says, "Moving forward, PSE's winter peaks may be reduced relative to summer peaks based on more recent climate warming trends. This has the potential to impact PSE's resource planning."

[5] Pages 2 and 3 of comments presents graphs prepared based on data from the National Oceanic and Atmospheric Administration of the hottest and coldest days for each year from 1932-2021.

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	E3's observation came before the Washington State Department of Commerce modified the Low Income Home Energy Assistance Program (LIHEAP) to help low-income residents install air conditioning equipment. As thousands of homes and apartments are retrofitted to help residents survive heat waves, demand for electricity on hot summer days will rise faster than PSE expects.
11.2	***Topic: Modeling does not account for risk of intense heat, drought and decreased wind*** PSE's modeling methods do not properly anticipate the risk of an intense heat wave event that occurs during a low hydro year. The correlation of heat and drought may be stronger than random sampling of historical data might indicate. For example, a hot year could melt snowpack early, increase evaporation, and force reductions in hydropower. Constraints on hydropower plants could occur at the same time that customer loads increase due to more prevalent air conditioning. This possibility was studied by the Pacific Northwest National Laboratory in 2019, which produced a short video to explain their findings in simple terms. The transcript of the video makes the case clearly and succinctly: *The Pacific Northwest relies on hydropower to meet nearly half of its annual demand. Hydropower is affected by how much snow melts each year, and when it melts. Historically, the greatest demand for electricity occurs in the cold winter months. Researchers from PNNL conducted a study to see how climate change could affect electricity delivery. They found that climate change nearly eliminated power shortfalls in winter, but greatly increased the frequency of shortfalls in the summer. Lower stream flows and greater demand for cooling created this risk. Their results show that power systems are affected by multiple stressors simultaneously, and these can cancel and compound each other, sometimes in unexpected ways. As power providers look to the future, planning for climate change may be far more challenging than previously thought.* In 2019, less than a quarter of PSE's energy mix came from hydropower. PSE may claim that constrained hydro is not a major concern for the company. But if hydropower is reduced on a regional basis, market prices for electricity will rise. To keep prices in check, PSE will want to maximize use of its gas and wind resources. However, wind energy may also decline during a heat wave. PSE appears not to model a possible correlation between extreme heat and lower wind speed. Drought conditions and reduced hydro availability have impacted our state in the recent past. The map below shows that while electric grids across the country were producing less emissions, in the Pacific Northwest —and Washington in particular—emissions were increasing due to a drought that occurred between

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	2016-2019.[6] In PSE's case, coal and gas produced most of the company's electricity. However, after 2025, coal will no longer be available, so PSE is likely to turn to gas, which is no better for the climate than coal.
11.3	***Topic: Old temperature data over-emphasizes winter peak loads and slows investment in solar and batteries*** PSE's continued reliance on old temperature data causes the company to over-emphasize winter peak loads. It comes as no surprise that PSE concludes that wind has a better annual load carrying capacity than solar because it is generally more available during winter months. However, over-investment in wind and meager investments in solar may leave customers vulnerable to a heat wave that coincides with low wind speeds. We ask for a more balanced acquisition strategy, including more solar and more battery storage to provide backup for likely peak loads in the summer.
11.4	***Topic: Modeling process remains opaque and biased to addressed old weather patterns and does not align with other northwest utilities*** PSE is not properly accounting for the significant challenges (and opportunities) posed by climate change. PSE's modeling process remains opaque and biased to address weather patterns from decades past, not for a realistic future. Compared to other northwest utilities such as PacifiCorp and Portland General Electric, PSE's 2025 resource additions are more concentrated on wind (50% of PSE's planned capacity acquisitions) compared to 20-35% for the other utilities. On the other hand, PSE's planned acquisition of energy storage (3% of acquisitions) is minor compared to 13-16% for the other utilities.

[6] Map shown on page 5 of joint comments.