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May 6, 2021

Mark Johnson
Executive Director and Secretary
Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98504-7250

RE: Comments of Renewable Northwest, Docket UE-200304
Utilities and Transportation Commission's January 5, 2021, Notice of Opportunity to File Written Comments Relating to Puget Sound Energy's 2021 Final Integrated Resource Plan for Electricity, Docket UE-200304.

I. INTRODUCTION

Renewable Northwest thanks the Washington Utilities and Transportation Commission ("the Commission") for this opportunity to comment in response to the Commission's May 6, 2021, Notice of Opportunity ("Notice") to File Written Comments relating to Puget Sound Energy's 2021 Final Integrated Resource Plan ("Final IRP") for Electricity, which Puget Sound Energy ("PSE" or "the Company") filed April 1, 2021.

Renewable Northwest was an active stakeholder during the public participation process of PSE's Draft and Final IRP development, and we submitted written feedback on the Company's generic resource assumptions, transmission constraints, portfolio sensitivities, electric portfolio model, flexibility analysis, and draft portfolio results. In our previous comments to the Commission, we noted various areas for improvement in the Draft IRP for PSE and the Commission to consider, bearing in mind the important role of this IRP to plan for compliance with the clean energy standards of Washington's Clean Energy Transformation Act ("CETA"), and as such, to inform PSE's first Clean Energy Implementation Plan ("CEIP"), set to be published later this year.[1] Our recommendations included revision of PSE's analytical assumptions and resource adequacy considerations, as well as various sensitivity analyses with the goal of helping the Company identify a clean, cost-effective and non-emitting portfolio with the best likelihood of meeting CETA's clean energy standards.

Unfortunately, in several key respects that we outline below, the Company's Final IRP does not reflect our broad recommendations. We hope the Company considers these comments as it

[1] WAC 480-100-640

moves forward with its 2020 All-Source RFP and the upcoming CEIP to be filed in accordance with CETA. In these comments, we identify areas where PSE's Final IRP does not align with the most current resource costs and operational characteristics of emerging resources. We also offer recommendations for revising PSE's key analytical assumptions related to storage resources, resource adequacy considerations, and a portfolio sensitivity analysis approach with the goal of nudging the Company toward a least-cost portfolio with the best likelihood of meeting CETA's clean energy standards.

II. COMMENTS

1. Changes to electric resource assumptions would help PSE effectively consider emerging non-emitting capacity resources as an alternative to risky gas peakers.

PSE's preference for dispatchable thermal resources to maintain resource adequacy may create significant financial risks for PSE and its customers brought on by investing in gas infrastructure that may be underutilized, prone to fuel supply risks, and stranded in the future, and we still have questions about the Company's resource assumptions which informed the portfolio model to opt for new thermal resources rather than non-emitting capacity resources following 2025 coal retirements. In the Final IRP, PSE concludes that "this IRP determined that the limited-run use of simple-cycle combustion turbines (peakers) operated on biodiesel (a CETA complaint fuel) is the most cost effective means of ensuring resource adequacy." However, PSE's modeling of alternative fuel enabled combustion turbines -- limited to sensitivity W in the Draft IRP -- may not support the claim that this resource is least cost. Sensitivity W explores a ramped schedule of DER procurements with biofuel as the fuel source for new frame peaker resources. Because PSE assumes a *fixed* biofuel price of $30.53 per million British Thermal Units over the entire study period, the model does not consider volatility of that market, inflation, or limited access to the resource. In addition to these factors, building new gas infrastructure is antithetical to CETA and creates significant financial risks of stranded assets for PSE and its customers due to large capital investment and limited use of the resource. The most recent Lazard's Levelized Cost of Energy Analysis compares new-build wind and solar against the marginal cost of operating *existing* combined-cycle gas units and shows that renewable resources are cost-competitive[2]; given trends in resource costs, it is very possible that portfolios of renewable resources, storage, efficiency, and demand-side management will similarly render gas peakers uneconomical and obsolete well before utility customers have paid for utilities' investments in those peakers.

[2] Lazard's Levelized Cost of Energy Analysis--Version 14.0 at 7 (Oct. 2020), *available at* https://www.lazard.com/media/451419/lazards-levelized-cost-of-energy-version-140.pdf.

We also have particular concerns in PSE's treatment of the cost and operational characteristics of storage resources; these characteristics are flowing into the modeling and creating a false picture that storage and hybrid renewable-plus-storage resources are not cost-effective capacity resources in the near-term. On the contrary, recent cost declines and efficiency improvements particularly in Li-ion battery storage technology have supported an emerging consensus that standalone storage and hybrid resources are increasingly essential grid resources, capable of performing multiple services including providing capacity and ancillary services in addition to energy needs. This value, however, can be challenging to capture -- for example, in developing its 2019 IRP preferred portfolio featuring 600 MW of new storage resources in the action-plan window, PacifiCorp had to force its system-optimizer model not to select stand-alone solar, with the result that the model instead picked hybrid solar-plus-storage that yielded a lower overall system cost after running the portfolio through stochastic risk analysis.[3] PacifiCorp's experience goes to show that accurately reflecting the value of storage resources in portfolio modeling may require significant attention from PSE's planning team, likely including additional storage and hybrid configurations and possibly including manual modeling adjustments.

In the "Electric Resource Assumptions" section, PSE provides details on the type and operational characteristics of the resources considered in the 2021 IRP. We suggest the following recommendations that would provide better insight into how resources are operated:

A. **Pumped-hydro storage:** It is our understanding that PSE considers splitting up the nameplate capacity of the generic pumped hydro resource to account for reasonable joint ownership considerations. In doing so, the model assumes that PSE's share from the resource would be inputted in 25 MW increments. As PSE rightly mentions, pumped hydro storage resources can provide capacity as well as sub-hour flexibility, two key value streams that will be increasingly important in the future power system. Additionally, since the nameplate capacity of a typical pumped hydro storage resource ranges from 250 MW to 3 GW, a model that reflects less than 25% of the average capacity of a pumped hydro resource may not accurately reflect the costs and benefits of the resource. Thus, we suggest that PSE consider at least **100-150 MW** increments of nameplate capacity of pumped hydro with 8-, 10-, and 12-hour duration in their modeling to ensure the resource receives thorough consideration. Additional assessment is warranted because of pumped hydro's unique characteristics as a CETA-compliant resource, one that can integrate large shares of renewables into PSE's system, and one that can provide flexibility (valued at $10/kW-year in this IRP) and other reserve products required to balance the grid.

[3] PacifiCorp 2019 IRP at 199.

B. **Hybrid resources:** PSE has modeled three different combinations of hybrid resources: eastern Washington solar + 2-hour Lithium-ion battery, eastern Washington wind + 2-hour Lithium-ion battery, and Montana wind + pumped hydro. While we appreciate PSE's addition of these resources into this IRP cycle and the company's recognition of the emergence of hybrid projects as cost-effective, non-emitting resources, below we highlight some additional hybrid resource configurations that may enhance PSE's modeling of hybrids and provide better understanding for the current and future IRPs.

First, hybrid resources can provide valuable energy during peak demand or hours with highest probability of loss of load ("LOLP") because they have the inherent ability to shift delivery of energy based on the needs of the grid. This means hybrids can provide **capacity and additional grid flexibility**, thereby helping to integrate large shares of renewable energy resources. While PV coupled with batteries is the most prevalent hybrid resource currently, utility innovations in this field have shown that concepts like triple-hybrids consisting of wind + solar + batteries are also techno-economically viable generation resources.[4]

Second, typically solar or wind resources are coupled with a **4-hour duration** Li-ion battery system to ensure sufficient MWhs are shifted from the generating resource to the battery during low-demand hours to avoid curtailment and allow for discharge across high-demand hours, as well as to ensure that the additional capital cost of the battery is effectively utilized to the maximum extent.[5] Modeling 2-hour Li-ion batteries might not lead to complete realization of benefits that a 4-hour system can provide, a result that could skew the selection of hybrid and storage resources -- or lack thereof -- in a preferred portfolio.

Finally, hybrid resources are also flexible in terms of the variety of operational **configurations** available. Apart from the generic AC-coupled systems, recent industry developments in DC-coupled systems have provided additional options to deploy hybrid resources. In these systems, batteries provide the extra benefit of recapturing "clipped" energy from oversized solar systems, and enable low-voltage harvesting periods when inverters cannot generate power from the solar system. Modeling different operational configurations could similarly unlock benefits that change the composition and costs of PSE's resource portfolios.

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[4] *See*, *e.g.*, Portland General Electric's December 2020 press release regarding the wind + solar + battery storage Wheatridge Renewable Energy Facility procured as a result of a 2018 competitive solicitation: https://portlandgeneral.com/news/2020-12-8-pges-and-nextera-energy-resources-leading-edge-renewable-energy.

[5] NREL Annual Technology Baseline, 2020, *available at* https://atb.nrel.gov/electricity/2020/index.php?t=st

2. **Granular modeling capabilities are essential to unlock full value streams of storage and hybrid resources.**

Most utility IRPs including PSE's Final IRP still use methods that do not adequately model energy storage. Typical IRP models use three inputs—forecasted demand, the capital cost of available technologies, and those technologies' operating profiles—to calculate long-term economic options for system capacity. These models tend to be simplistic because they only capture the uncomplicated operations of traditional generation units providing capacity. In contrast, current-day advanced energy storage provides high value grid flexibility services, like frequency regulation or ramping support, in addition to capacity.

A large-scale energy storage resource dedicated to providing peak capacity when needed—typically a four-hour period in the morning or afternoon and early evening—can also provide grid services for the many hours when its peak capacity is not needed. In fact, PSE's All-Source RFP mentions the ability of battery energy storage systems both to "charge and discharge all usable energy two times per day up to 60 days per year" and to provide ancillary services on an unlimited basis.[6] This configuration would allow storage resources to deliver energy during PSE's peak demand periods through multiple discharge cycles as specified by the company's LOLP heatmap. It is not clear from the Final IRP whether the generic resource assumptions for Li-ion battery storage systems include cycling twice in a day; limiting cycling to once per day may have been the cause of PSE's lower-than-expected ELCC values. RNW recommends PSE's future modeling and ELCC calculations reflect the base configuration provided in the RFP because this configuration provides necessary flexibility for developers to design systems catering to PSE's unique winter peak needs, and we further recommend that this potential mismatch be remedied in any analysis pertaining to battery storage resources prior to the next IRP cycle (including the RFP and CEIP).

Storage resources are unique because they are "always on", fast-ramping and available for service, in contrast to traditional generation units that need to be started up and shut down to provide peak capacity and other services. For this reason, it is important to update the methods used in IRPs to accurately model advanced storage. Models that use sub-hourly intervals can capture the flexibility of storage operations to provide both capacity and grid services like ancillary services which are also mentioned in the PSE's 2021 All-Source RFP. Several validated commercial models are available that can calculate economic resource options including intra-hourly dynamics, such as PLEXOS and SERVM. If sub-hourly modeling is not possible,

[6] Puget Sound Energy 2021 All-Source Request for Proposal. Published on April 1, 2021. Available at: https://www.pse.com/-/media/PDFs/001-Energy-Supply/003-Acquiring-Energy/000_main_All-Source-RFP_040121.pdf?sc_lang=en&hash=C94AA19A5F074F78CADD1DA699254BC8

then at minimum an hourly chronological production cost model should be used, rather than sampling from a small set of hours from each season. This is similarly true for hybrid resources, which have the added benefit of a clean energy resource charging the storage component to deliver during peak load hours.

In terms of resource costs, planners should use a declining cost curve when projecting the future cost of storage resources based on current industry trends. Utility IRPs typically assume the cost of conventional supply technologies increase over time, based on inflation, since combustion turbines and other traditional generation technologies are no longer experiencing significant cost declines. Advanced energy storage including battery storage is different because the rapidly increasing scale of manufacturing capacity and deployment has resulted in significant unit cost reductions. This trend is expected to continue within Washington's 20-year IRP planning window. A recent report from NREL studying market trends in the storage industry projects a steep drop in Li-ion capital costs from $380/kWh currently in 2021 to less than $200/kWh in 2030[7].

3. **Resource adequacy for a changing grid mix.**

PSE has established a 5 percent loss of load probability (LOLP) resource adequacy metric to assess physical resource adequacy risk. LOLP measures the likelihood of a load curtailment event occurring in any given simulation regardless of the frequency, duration, and magnitude of the curtailment. Renewable Northwest appreciates the Final IRP's detailed description of PSE's efforts to maintain a reliable and adequate system during all hours of the year using the multi-scenario probabilistic Resource Adequacy Model ("RAM"). Evaluating the capacity contribution of individual resources is an integral part of this analysis, which informs the planning reserve margin ("PRM") to maintain the system under the standard of 5% loss of load probability ("LOLP"). As mentioned in our previous comments, we urge PSE to consider the following points:

A. The LOLP matrix for 2027 and 2031 shows peak demand hours for winter months during mornings from (8 a.m. - 11 a.m.) and evenings from (6 p.m. to 10 p.m.); as noted above, the resource needs associated with these peaks can likely be met by a **portfolio of flexible resources such as pumped hydro, standalone storage, hybrids, efficiency, demand response, and market purchases at a lower or comparable cost** than that associated with the biogas fueled gas turbine that appears in PSE's preferred portfolio. The duration (assuming full discharge) for all storage resources combined contributes up

[7] Cost Projections for Utility-Scale Battery Storage: 2020 Update. National Renewable Energy Laboratory (NREL). Wesley Cole and A. Will Frazier. Available at: https://www.nrel.gov/docs/fy20osti/75385.pdf

to 16 hours, excluding demand response. In addition, if PSE considers two cycles/day for batteries, that configuration would allow these resources to address PSE's morning and evening peaks, especially when considered as 4-hour rather than 2-hour storage. Thus, we recommended that PSE consider addressing its capacity needs with a portfolio of clean resources instead of investing in new gas infrastructure which will likely end up being stranded, leading to financial losses for the company and its customers.

B. The Final IRP's peak capacity credit for hybrid solar + storage resources appears to be skewed because coupling solar or wind with 2-hour Li-ion storage contributes much less to peak capacity than a similar resource paired with 4-hour storage, as mentioned previously. In fact, **4-hour storage is the industry standard** for pairing with renewable resources due to their lower $/kW capital costs[8] as well as costs related to the balance-of-system ("BoS")[9], in addition to the ability to provide 4-hour dispatch during evening hours when the solar is ramped down and demand is high on the grid. Research has shown that hybrid solar + battery storage (4-hour duration) can deliver greater than 95% ELCC in the Western US at a lower cost than a combustion turbine peaker power plant in an analysis conducted using Strategic Energy and Risk Valuation Model (SERVM) by Astrape Consulting.[10]

C. PSE is an active participant in the regional resource adequacy program ("RAP") being developed by the Northwest Power Pool ("NWPP") in consultation with the Southwest Power Pool ("SPP"). This program has the ability to unlock the geographical and resource diversity of the region and allow utilities to share resources during stress hours instead of following the traditional "go-it alone" approach. The program is currently in the detailed design phase, and its non-binding forward showing will launch in Q3-2021, with the binding + operational program to be launched in 2024 -- two years before PSE's Final IRP shows a need for new flexible capacity. Thus, it would be prudent for PSE to assess whether participation in the program could reduce or even eliminate the need for new thermal capacity assets, especially when combined with some set of the non-emitting resources discussed above.

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[8] See Figure 9. 2018 U.S. Utility-Scale PhotovoltaicsPlus-Energy Storage System Costs Benchmark. Fu et al. 2018. NREL. Available at: https://atb.nrel.gov/electricity/2020/index.php?t=st

[9] Balance-of-system typically includes components like wiring, mounting, inverters and other devices excluding the solar panel or wind turbine blades.

[10] California Public Utility Commission. Joint IOU Study. August 2020. Available at: https://www.astrape.com/2020-joint-ca-iou-elcc-study-report-1/

4. **Modeling a clean, non-emitting capacity addition portfolio sensitivity would be important to understand that portfolio's values and costs.**

Before we filed our previous comments, we had understood that PSE staff would run a sensitivity allowing the model to select from a *mix* of storage options, notably 4-hour lithium-ion batteries and 8-hour pumped hydro storage. Renewable Northwest was concerned and disappointed to see that this portfolio sensitivity was not included in both the Draft and Final IRP. PSE's capacity needs occur mostly during winter mornings and evenings in the months of January and February as per the LOLP heat map shown below and shared in the Final IRP (Figure 3-11). To meet these needs especially the highest loss of load hour windows highlighted in Figure 1, PSE could utilize a portfolio of clean, non emitting capacity resources to provide energy during the separate 4-hour windows instead of building assets which are underutilized and have the increasing risk of being stranded in a few years.

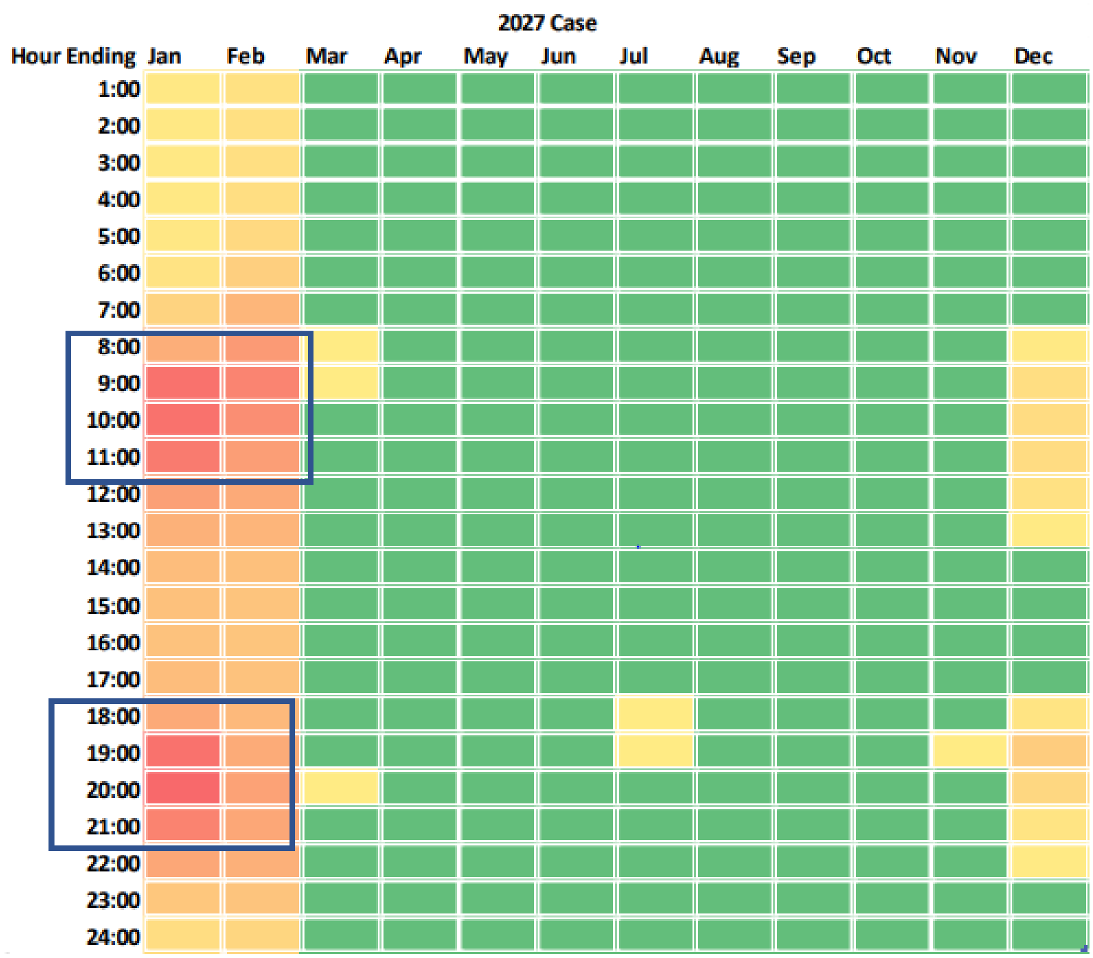

Figure 1. Loss of Load Hour heatmap for PSE's system in 2027 with winter super-peak windows highlighted.

Meeting winter peak needs using non-emitting capacity resources including a combination of pumped hydro storage, battery storage, hybrids, efficiency, and demand response provides PSE an opportunity to be CETA compliant over the long term and invest in emerging technologies which are most likely to be status quo in the future due to fast-changing state and federal policy efforts, significant tax incentives, and rapidly decreasing capital costs.

Another important factor to note is the changing nature of the climate and its effect on supply and demand characteristics of the region. We applaud PSE for conducting the "Temperature Sensitivity" analysis as part of this IRP by utilizing Northwest Power & Conservation Council's ("NPCC") downscaled climate model to inform PSE's system load and evaluate the loss of load hours for years 2027 and 2031 using climate-adjusted datasets. The analysis results show (Figure 7-33) the significant trend of increasing loss of load events during the summer, especially during the late evening periods, as a result of warming temperatures. These changing weather patterns create a significant opportunity for PSE to invest in standalone storage and hybrid renewable plus storage technologies equipped to deliver energy during these hours which is proven by the nearly doubling of capacity credit values for these resources (tabulated in Figure 7-34).

III. CONCLUSION

Renewable Northwest thanks PSE and the Commission for their consideration of this feedback. We are optimistic that the changes and additional analysis we have recommended above will help PSE to identify a least-cost portfolio that also puts the Company on a path to achieving CETA's clean energy standards and the Company's own emission reduction goals. We look forward to continued engagement as a stakeholder as we move from this 2021 IRP process into PSE's 2021 All-Source RFP and its first CEIP.

Sincerely,

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