EXH. PJP-1Tr
DOCKET UE-210795
PSE'S CEIP
WITNESS: PHILLIP J. POPOFF

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**

PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF

PHILIP J. POPOFF

ON BEHALF OF PUGET SOUND ENERGY

REVISED VERSION
JANUARY 9, 2023

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PUGET SOUND ENERGY

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I. INTRODUCTION

Q. Please state your name, business address, and position with Puget Sound Energy.

A. My name is Phillip J. Popoff, and my business address is Puget Sound Energy, P.O. Box 97034, Bellevue, Washington 98009-9734. I am employed by Puget Sound Energy ("PSE" or "Company") as Director, Resource Planning Analytics.

Q. Please describe your background and professional qualifications.

A. I have worked in the energy utility sector for 30 years. I worked at the Virginia State Corporation Commission for two years, the Washington Utilities and Transportation Commission for three years, and at PSE for 25 years. Currently, I lead PSE's Integrated Resource Planning ("IRP") and Load Forecasting teams. An exhibit detailing my professional qualifications is provided as Exhibit PJP-2.

Q. What is the purpose of your prefiled rebuttal testimony?

A. My testimony addresses questions that arose in response testimony regarding modeling in PSE's Clean Energy Implementation Plan ("CEIP"). Specifically, my testimony addresses the methodology that PSE used to model the social cost of greenhouse gases in the CEIP Preferred Portfolio and the No-CETA Portfolio.

My testimony rebuts relevant portions of the prefiled response testimony of Elaine K. Hart, Exh. EKH-1T, submitted on behalf of NW Energy Coalition and Front and Centered ("NWEC and Front and Centered") relating to treatment of social cost of greenhouse gases and effective load carrying capability of energy storage in long-term capacity expansion planning optimization.

Q. Please summarize your prefiled rebuttal testimony.

A. My testimony explains why PSE's approach to social cost of greenhouse gases modeling and effective load carrying capability of energy storage is reasonable and preferable to the recommendations and requests from NWEC and Front and Centered in this case. I will explain the technical aspects of (i) PSE's approach to modeling the social cost of greenhouse gases in its 2021 CEIP, and (ii) PSE's approach to analyzing effective load carrying capability of energy storage in its 2021 CEIP.

II. PSE'S APPROACH TO SOCIAL COST OF GREENHOUSE GAS MODELING IS REASONABLE

Q. Please describe PSE's overall approach and strategy for its social cost of greenhouse gas modeling decisions.

A. PSE incorporates social cost of greenhouse gases in its modeling as an externality cost (or adder). This methodology is reasonable because it accurately reflects how power plants are expected to operate. As described in PSE's CEIP (Table 5-2), total costs = direct costs + externality (or pollution) costs. Direct costs are those that PSE must pay to other parties, which become part of the Company's costs to customers. Direct costs include fixed cost items such as capital and fixed operations and maintenance, along with variable costs that are affected by dispatch, including fuel and variable operations and maintenance costs. Externality costs associated with greenhouse gas emissions are real costs to society but are not internalized into market mechanisms or operation decisions and are therefore called "externalities."

Q. Can you summarize how PSE reflects the social cost of greenhouse gases in its analytical process?

A. PSE uses Aurora to incorporate analysis of the social cost of greenhouse gas emissions. As explained more thoroughly in PSE's CEIP, Aurora is an electric modeling forecasting and analysis software that uses the western power market to produce hourly electricity price forecasts and it also identifies hypothetical portfolios of resources.

Typically, in Aurora, there are two model runs, which together reflect PSE's analysis of the social cost of greenhouse gas emissions. First is the long-term capacity expansion model. This analysis is based on hourly sampling to develop portfolios and determine the lowest cost mix of resources through the entire planning horizon. This sampling approach is important to manage the run-time needed to solve the cost minimization of resource additions given so much data and so many constraints. Once that long-term capacity expansion is determined, there is a full hourly run. The full hourly run takes the resources from the long-term capacity expansion, along with PSE's existing resources, and dispatches them using hourly data for the entire planning horizon to better refine operation and cost forecasts.

To model social cost of greenhouse gases as an externality cost, PSE first runs the long-term capacity expansion and the full hourly model without a carbon cost, then uses operational data of the hourly dispatch to estimate the amount of greenhouse gas, by resource, by year. Then, PSE takes the tons of greenhouse gas pollution, by source, and multiplies it by the social cost of greenhouse gas emissions. That cost represents the estimated pollution cost by resource by year. The estimated pollution cost by year is then put back into the long-term capacity expansion model onto each resource as a fixed cost (*i.e.*, an adder) that does not affect dispatch decisions. The next long-term capacity expansion run reflects the social cost of greenhouse gases of emitting resources in a way that does not affect economic dispatch. Once the long-term capacity expansion run is completed, an hourly dispatch is run for the entire planning horizon to refine operations and costs, as noted above.

Q. NWEC and Front and Centered submitted testimony asserting that PSE does not incorporate the social cost of greenhouse gases as a direct cost that affects economic dispatch of PSE's fossil fuel plants.[1] Is that correct?

A. Yes, PSE's planning models treat social cost of greenhouse gases as an externality cost, not a direct cost that will impact economic dispatch of resources, based on requirements of CETA.

Q. Does CETA require utilities to incorporate consideration of the social cost of greenhouse gas emissions when making economic dispatch decisions in its modeling?

A. No. CETA requires utilities to consider the social cost of greenhouse gases when making intermediate to long-term decisions, but CETA does not require utilities to apply this analysis when making economic dispatch decisions.[2] The rules in the Commission's General Order R-601 in Dockets UE-191023 and UE-190698 (consolidated) do not prescribe a specific methodology for incorporating the social cost of greenhouse gases into portfolio optimization, and allow the social cost of greenhouse gases to be applied as a planning adder or as a dispatch cost. PSE applied it as a planning adder, or externality cost. PSE has never incorporated the social cost of greenhouse gas emissions as an adder when making economic dispatch decisions. In PSE's current general rate case filing, Docket UE-220066, PSE did not include the social cost of greenhouse gas

[1] *See* Hart, Exh. EKH-1T at 10:15-11:3.
[2] RCW Section 19.280.030(3)(a)

emissions as a dispatch cost in power costs and no party to that proceeding (including NWEC and Front and Centered) recommended that PSE do so.

Q. **Why has PSE chosen to model social cost of greenhouse gas emissions as an externality in the long-term model run instead of a dispatch cost**?

A. Because in operations, the social cost of greenhouse gases will not be treated as a dispatch cost, as described above. PSE has two choices: (1) model social cost of greenhouse gases as an externality that will not affect dispatch, or (2) model it as a dispatch cost. PSE's choice to treat social cost of greenhouse gases as an externality cost is reasonable because it is consistent with how the system will operate.

III. SUMMARY RESULTS OF PERFORMING DR. HART'S RECOMMENDED ANALYSIS

Q. **Dr. Hart recommended the Commission require PSE analyze the social cost of greenhouse gas emissions as a dispatch cost? Did PSE perform this analysis?**

A. Yes. In response to NWEC and Front and Centered's response testimony, PSE developed a CETA and a "No-CETA" portfolio using the social cost of greenhouse gases as a dispatch cost, rather than an externality, as recommended by Dr. Hart.[3] With those results, my testimony below illustrates the impact on incremental costs using Dr. Hart's methodology.

[3] *See* Hart, Exh. EKH-1T at 3:15-4:2.

Q. Can you please describe how PSE incorporated the social cost of greenhouse gases as a dispatch cost for PSE's fossil fuel plants in the long-term capacity expansion run?

A. Yes. To implement Dr. Hart's methodology, the social cost of greenhouse gases was applied to all of PSE's existing fossil fuel plants as a dispatch cost in the long-term capacity expansion run. The social cost of greenhouse gases was also applied as a variable cost on market imports to PSE's system, to ensure consistent treatment of greenhouse gas pollution associated with market purchases. This was accomplished by using the emission rate for unspecified market purchases as provided in RCW 19.405.070(2), which sets the rate at 0.437 metric tons of carbon dioxide per megawatt-hour (MWh) of electricity, unless otherwise determined by the Department of Ecology. This emission rate was then multiplied by the social cost of greenhouse gases ($/metric ton of carbon dioxide) to get a $/MWh charge by year. The charge was then applied as a variable transmission cost for market purchases. This means the social cost of greenhouse gases was incorporated as dispatch cost for both fossil fuel plant operation and market purchases in deriving the least cost portfolio from the long-term capacity expansion run.

Q. How did PSE apply the social cost of greenhouse gases in the <u>hourly dispatch run</u> to implement Dr. Hart's methodology?

A. In the hourly dispatch run, PSE started with the least cost plan from the long-term capacity expansion model, as described above. In the hourly model dispatch run, the social cost of greenhouse gases was not included in the economic dispatch, which is consistent with Dr. Hart's methodology.

Q. How did treating the social cost of greenhouse gases as a direct dispatch cost in the long-term capacity expansion run impact results of the CETA case, relative to treating social cost of greenhouse gases as an externality cost?

A. Overall, incorporating the social cost of greenhouse gases as a direct dispatch cost had very little impact on the CETA case during the CEIP period. Table 1 CETA Case Comparisons, below, compares resource builds, cumulative direct costs, and emissions. This table illustrates that treating the social cost of greenhouse gases as a dispatch cost did not materially affect resource additions. This table also illustrates that differences in total direct costs and emissions are immaterial in this CEIP cycle (2022-2025).

Table 1 CETA Case Comparison (2022-2025)

CETA Case		Existing Resources	New Emitting	Market Purchase	Market Sales	New Non-emitting	Total
Resource Builds (nameplate MW)	SCGHG as Externality Cost	-	-	NA	NA	~~559~~ 1146	~~559~~ 1146
	SCGHG in Dispatch	-	-	NA	NA	~~559~~ 1146	~~559~~ 1146
Cumulative Direct Cost ($000)	SCGHG as Externality Cost	2,238,899	-	197,638	(216,316)	~~552,360~~ 872,283	~~2,772,582~~ 3,092,505
	SCGHG in Dispatch	2,239,019	-	197,582	(216,359)	~~552,260~~ 872,283	~~2,772,502~~ 3,092,525
Emission (short ton)	SCGHG as Externality Cost	26,341,962	-	4,142,427	-	-	30,484,388
	SCGHG in Dispatch	26,344,304	-	4,140,207	-	-	30,484,511

Q. Can you summarize how treating social cost of greenhouse gases as a dispatch cost in the long-term capacity expansion for the No-CETA case affects results?

A. Yes. Treating the social cost of greenhouse gases as a dispatch cost in the long-term capacity expansion model for the No-CETA case adds ~~200~~ 800 MW of Washington Wind in 2025, and moves one Frame Peaker unit (237 MW) from 2025 to 2026, relative to treating social cost of greenhouse gases as an externality cost. This increases the total cost of the No-CETA case by $~~50.6~~89.4 million over the four-year CEIP period (2022-2025). Emissions are approximately ~~0.68~~2.55 percent lower when the social cost of greenhouse gases is applied as a dispatch cost over the period, but given complexity of this analysis, this is not a material difference. The new resource builds, CEIP period costs, and emission summary are shown in Table 2 below.

Table 2 No-CETA Case Comparison (2022-2025)

No-CETA Case (Portfolio S Bundle 11)		Existing Resources	New Emitting	Market Purchase	Market Sales	New Non-emitting	Total
Resource Builds (nameplate MW)	SCGHG as Externality Cost	-	~~-~~ 237	NA	NA	~~445~~ 191	~~445~~ 428
	SCGHG in Dispatch	-	-	NA	NA	~~645~~ 991	~~645~~ 991
Cumulative Direct Cost ($000)	SCGHG as Externality Cost	~~2,244,384~~ 2,243,009	~~-~~ 26,728	~~229,768~~ 229,084	~~(183,435~~ (185,010)	~~564,420~~ 561,475	~~2,855,136~~ 2,875,287
	SCGHG in Dispatch	~~2,242,975~~ 2,236,645	-	~~222,336~~ 208,611	~~(189,526~~ (206,953)	~~629,908~~ 726,395	~~2,905,694~~ 2,964,698
Emission (short ton)	SCGHG as Externality Cost	~~26,466,486~~ 26,428,214	~~-~~ 148,616	~~5,008,725~~ 4,998,216	-	-	~~31,475,211~~ 31,575,045
	SCGHG in Dispatch	~~26,434,426~~ 26,286,239	-	~~4,827,238~~ 4,483,451	-	-	~~31,261,664~~ 30,769,690

Q. Is the ~~200~~ 800 MW of additional wind in the No-CETA case being added during the CEIP period to meet resource adequacy needs during the CEIP period?

A. No. The No-CETA portfolio has adequate capacity to meet resource adequacy targets during the CEIP period without adding ~~2~~800 MW of wind in 2025. Table 3 illustrates the annual net capacity need prior to 2030 from the No-CETA case where social cost of greenhouse gases is treated as a dispatch cost. "Net capacity need" means the effective capacity of the portfolio minus the capacity needed to maintain a five percent "loss-of-load probability" resource adequacy target.[4] Table 3 illustrates the additional ~~2~~800 MW of wind is not needed until 2027, which is after the CEIP window. However, the underlying economics, such as diminishing tax incentives, makes it more cost effective to accelerate acquisition of that ~~2~~800 MW wind into the CEIP period to reduce the long-term net present value cost of the portfolio.

Table 3 Peak Capacity in MW (2022-2030)

Table for Peak Capacity		**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Peak Capacity Needs		5,656	5,706	5,792	5,845	5,906	5,972	6,054	6,103	6,182
SCGHG in Dispatch with the ~~2~~800MW Wind	Peak Capacity	5,886	6,059	6,104	~~6,144~~ 6,202	~~6,063~~ 6,120	~~5,988~~ 6,046	~~6,062~~ 6,119	~~6,137~~ 6,194	~~6,210~~ 6,311
	Surplus/ (Deficit)	231	352	312	~~299~~ 357	~~157~~ 215	~~16~~ 74	~~8~~ 65	~~33~~ 91	~~28~~ 129
SCGHG in Dispatch after Removing ~~2~~800MW Wind	Peak Capacity	5,886	6,059	6,104	6,114	6,032	5,958	6,031	6,106	~~6,180~~, 6,223
	Surplus/(Deficit)	231	352	312	269	127	(14)	(23)	3	~~(2)~~ 41

[4] "PSE uses a loss of load probability consistent with the Northwest Power and Conservation Council to determine the peak capacity need for its service territory." CEIP Chapter 2, pg. 31.

Q. How did Dr. Hart's methodology to incorporate the social cost of greenhouse gas emissions as a dispatch cost in the long-term capacity expansion affect the incremental cost analysis?

A. As shown in Table 2 above, Dr. Hart's recommendation to include the social cost of greenhouse gas emissions as a dispatch cost[5] adds an additional ~~2~~800 MW of wind and moves 237 MW of Frame Peaker from 2025 to 2026, resulting in an additional $~~50.6~~89.4 million in the difference between the CETA and No-CETA case. Using Dr. Hart's methodology indicates PSE could spend an additional $~~50.6~~89.4 million during the CEIP period to acquire renewable resources before hitting the two percent incremental cost threshold established in CETA.[6]

Q. Based on results of this analysis, do you believe PSE's approach of using the social cost of greenhouse gas emissions as an externality cost in the long-term capacity expansion in this CEIP filing, rather than as a dispatch cost, is reasonable?

A. Yes, PSE's approach of applying the social cost of greenhouse gases as an externality cost in the long-term capacity expansion model is reasonable. Applying the social cost of greenhouse gases as an externality cost is more consistent with economic price signals that will drive dispatch decisions. Therefore, PSE's methodology was reasonable.

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[5] *See* Hart, Exh. EKH-1T at 10:15-11:3.
[6] *See* RCW 19.405.060.

IV. PSE'S APPROACH TO MODELING AND ANALYZING ENERGY STORAGE EFFECTIVE LOAD CARRYING CAPABILITY IS REASONABLE

Q. What is the effective load carrying capability of a resource?

A. The effective load carrying capability of a resource measures the resource's ability to produce energy when the system is experiencing electricity shortfalls; that is, the peak capacity value of a resource. Effective load carrying capability provides a way to assess the capacity value of a resource to meet a reliability standard; PSE uses a five percent loss-of-load probability standard to determine the peak capacity needed for its service territory.

Q. Why is effective load carrying capability a critical metric in portfolio optimization?

A. In the IRP and CEIP portfolio optimization model, peak demand is a constraint in the capacity optimization problem. Peak demand needs are met by the summation of all available resources' effective load carrying capability adjusted capacity in each year across the study horizon. Different effective load carrying capabilities can result in different portfolios. Effective load carrying capability estimation is performed by resource adequacy analysis, which is critical to the resource planning process. The peak capacity constraint is one of the constraints in the portfolio optimization model. Other constraints include CETA renewable and non-emitting energy requirement and PSE's hourly loads. The modeling is complicated, and a change in the effective load carrying capability value of a resource may or may not affect the results of the optimization model.

Q. Did you review Dr. Hart's recommendation that the Company update the 2021 CEIP analysis with effective load carrying capabilities for storage resources from the draft 2023 Electric IRP Progress Report?

A. Yes. Dr. Hart recommended the Commission require PSE to update both the CETA and No-CETA cases described above using effective load carrying capabilities for storage developed for the draft 2023 Electric IRP Progress Report.[7]

Q. Did PSE re-run the portfolio analysis with updated effective load carrying capabilities being developed for the 2023 Electric IRP Progress Report?

A. No, PSE did not perform this analysis.

Q. Why not?

A. Dr. Hart's recommendation would require comprehensive changes to the underlying models used for the 2021 CEIP. When PSE updated its load forecast and resource adequacy modeling (including planning reserve margins and effective load carrying capabilities) to include climate change for the 2023 IRP Progress Report, the planning reserve margin and effective load carrying capabilities were differentiated seasonally. That is, PSE developed different planning reserve margins and effective load carrying capabilities for winter and summer seasons. However, the 2021 CEIP followed the 2021 IRP, which had only annual planning reserve margins and annual effective load carrying

[7] *See* Hart, Exh. EKH-1T at 4:5-7.

capabilities. The Aurora model used to develop the CEIP is not able to accommodate seasonal resource adequacy metrics. Further, PSE is still working on the draft 2023 Electric IRP Progress Report.

Q. Aside from not being able to modify the 2021 IRP/CEIP models to incorporate seasonal effective load carrying capabilities, do you have other concerns with Dr. Hart's recommendation to rerun the analysis with storage effective load carrying capabilities from the draft 2023 Electric IRP Progress Report?[8]

A. Yes. Temperatures underlying the load forecasts between the 2021 IRP/CEIP and the draft 2023 Electric IRP Progress Report are different, as are hydro generation conditions. So, adopting Dr. Hart's recommendation would result in using effective load carrying capabilities for energy storage that are inconsistent with effective load carrying capabilities for all other resources in the CEIP. It would also be inconsistent with load shapes in the demand forecast and inconsistent with hydro generation. For these additional reasons, updating just the storage effective load carrying capabilities in the modeling for the 2021 CEIP would not be reasonable.

Q. Should the Commission adopt Dr. Hart's recommendation to require PSE to rerun the CETA and No-CETA cases using storage effective load carrying capabilities from the draft 2023 IRP Progress Report?[9]

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[8] *See* Hart, Exh. EKH-1T at 4:5-7.
[9] *See* Hart, Exh. EKH-1T at 4:5-7. 38:11-14.

A. No. Such analysis is not as simple as updating assumptions, it would require material changes to the underlying models. Additionally, updating just the storage effective load carrying capabilities without updating effective load carrying capabilities for any other resources or other data creates considerable inconsistencies in assumptions that are inter-related.

PSE's 2023 Electric IRP Progress Report will be filed by March 31, 2023, and it will include a complete, consistent update of all these changes. As outlined in the commitments in Chapter 8 of the CEIP, changes to PSE's resource adequacy modeling (which includes updates to effective load carrying capabilities) will be included in the 2023 Biennial CEIP Update.

V. CONCLUSION

Q. Does that conclude your prefiled rebuttal testimony?

A. Yes, it does.