**EXH. PJP-1T**
**DOCKETS UE-240004/UG-240005 et al.**
**2024 PSE GENERAL RATE CASE**
**WITNESS: PHILLIP J. POPOFF**

**BEFORE THE**
**WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

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| **WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION,**<br><br>**Complainant,**<br><br>**v.**<br><br>**PUGET SOUND ENERGY,**<br><br>**Respondent.** | **Docket UE-240004**<br>**Docket UG-240005**<br>**(*consolidated*)** |
| **In the Matter of the Petition of**<br><br>**PUGET SOUND ENERGY**<br><br>**For an Accounting Order Authorizing deferred accounting treatment of purchased power agreement expenses pursuant to RCW 80.28.410** | **Docket UE 230810**<br>**(*consolidated*)** |

# PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF

# PHILLIP J. POPOFF

# ON BEHALF OF PUGET SOUND ENERGY

**SEPTEMBER 18, 2024**

**PUGET SOUND ENERGY**

**PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF PHILLIP J. POPOFF**

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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 over 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 27 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 rebuttal testimony?**

A. My rebuttal testimony corrects issues raised in response testimony about PSE's decarbonization study raised by Bradley T. Cebulko's in Exh. BTC-1T on behalf of Joint Environmental Advocates ("JEA"). PSE's updated decarbonization study

("Decarbonization Study") was filed under Docket UE-220066, et al., in compliance with Stipulation O in PSE's 2023 rate case ("Stipulation O").[1] The Decarbonization Study is included as the second exhibit, Exh. PJP-3, to my prefiled rebuttal testimony.

**Q. Can you summarize your rebuttal testimony?**

A. Yes. I will first give an overview of the process for developing the Decarbonization Study, which was to update assumptions from a prior study in order to examine the impacts of different gas utility electrification pathways to the electric system, gas system, costs, and emissions. Next, I will explain two minor corrections to the Decarbonization Study and explain why those corrections do not change conclusions in the Decarbonization Study nor render it fundamentally flawed. Finally, I will explain why PSE's Decarbonization Study, filed in Dockets UE-220066, et al., was generally framed properly, and relied on correct and reasonable assumptions and methods in light of its purpose, contrary to Cebulko's claims.

[1] *WUTC v. Puget Sound Energy*, Dockets UE-220066, *et al*. Final Order 24/10, Appx. A, Settlement Stipulation and Agreement on Revenue Requirement and All Other Issues Except Tacoma LNG and PSE's Green Direct Program at ¶¶ 65-66 (Dec. 22, 2022) (the "UE-220066 Settlement")

## II. PSE'S 2023 DECARBONIZATION STUDY

**Q. Did you review Cebulko's testimony regarding PSE's updated gas decarbonization study?**

A. Yes. I reviewed Cebulko's testimony regarding PSE's Decarbonization Study.

**Q. Generally, do you agree with any portion of Cebulko's testimony regarding the Decarbonization Study?**

A. I agree with Cebulko's overall recommendation that the Washington Utilities and Transportation Commission ("Commission") not rely on PSE's Decarbonization Study to develop a general electrification program. *See* Cebulko, Exh. BTC-1T at 11:3-5. The Decarbonization Study was not intended to support development of a general electrification program, though it does include useful information as policies, strategies, and programs are developed in the future. Additionally, I agree with Cebulko that total appliance and installation costs were incorrectly displayed as incremental costs relative to the reference case in two slides of the Decarbonization Study and correct that mistake, as explained further below.

**Q. Do you disagree with any portion of Cebulko's testimony relating to the Decarbonization Study?**

A. I disagree with the remainder of Cebulko's testimony regarding PSE's Decarbonization Study—and specifically that the Decarbonization Study (1) is fundamentally flawed and (2) contains flawed assumptions that skew results and

portrays electrification to be more costly than it is—the correction noted above does not impact conclusions of the Decarbonization Study.

## A. Process For Developing PSE's 2023 Decarbonization Study

**Q. Can you provide some procedural context for the Decarbonization Study?**

A. Yes. The Decarbonization Study updates a prior 2021 study. In 2021, PSE contracted with Energy and Environmental Economics ("E3") to build on prior work that E3 had done to examine different decarbonization pathways. The 2021 decarbonization study was specifically intended to examine whether a "Carbon Managed Out" pathway, which relies on hybrid heating systems, would be viewed as commercially viable from a customer perspective. It also examined how the pathways identified in E3's prior study would affect the need for infrastructure.

As part of the settlement in PSE's 2022 general rate case, PSE agreed to file an update to its 2021 decarbonization study. The specific requirements for the updated study were provided for in "Stipulation O" of the settlement agreement.[2] In particular, Stipulation O stated: "PSE's updated decarbonization study will build off the gas decarbonization study prepared for PSE by E3 with more up-to-date assumptions regarding Cold Climate Heat Pumps ('CCHPs') for targeted electrification."[3] In other words, the Decarbonization Study was specifically

[2] *WUTC v. Puget Sound Energy*, Dockets UE-220066, *et al*. Final Order 24/10, Appx. A, Settlement Stipulation and Agreement on Revenue Requirement and All Other Issues Except Tacoma LNG and PSE's Green Direct Program at ¶¶ 65-66 (Dec. 22, 2022) (the "UE-220066 Settlement")

[3] *Id*.

designed to address the requirements of Stipulation O, but retained the same framework as the prior 2021 study.

**Q. Did PSE comply with the terms of Stipulation O?**

A. Yes. PSE's Decarbonization Study properly complied with each of the terms of Stipulation O. A summary of updates provided in the Decarbonization Study that ties to the requirements of Stipulation O is provided in Exh. PJP-3 of my rebuttal testimony at slides 18 and 19.

**Q. Did PSE seek input on the Decarbonization Study from settlement parties, including JEA?**

A. Yes. Prior to finalizing its updated analysis, PSE shared its methodology and inputs with settling parties at least twice—on January 20, 2023 at an initial meeting to discuss scope and on June 29, 2023 to discuss methodology and preliminary results. Representatives from JEA attended those meetings, and neither JEA nor any party raised concerns regarding the methodology or framing of the Decarbonization Study.

PSE also presented the results of the updated Decarbonization Study to settlement parties on three occasions, including JEA. On September 28, 2023, PSE coordinated a meeting with the settling parties to present PSE's draft Decarbonization Study model outputs, including draft electric and gas utility costs, electric and gas portfolio outputs, and other results. On November 8, 2023, PSE held a meeting with the settling parties to present draft financial results of the

Decarbonization Study. And on December 8, 2023, PSE organized a meeting with the settling parties to present the final results of the Decarbonization Study. Again, JEA representatives attended these meetings and did not raise any of the concerns now raised in Cebulko's response testimony.

PSE filed its Decarbonization Study on December 21, 2023 in Docket UE-220066, *et al*., in compliance with Stipulation O.

**Q. Are there any other requirements relating to electrification provided in Stipulation O?**

A. Yes. Per Stipulation O, PSE is taking the key findings from the Decarbonization Study and incorporating them into a Targeted Electrification Strategy as well as the Company's future planning processes. PSE intends to file its report summarizing the results of the Targeted Electrification Pilot and its Targeted Electrification Strategy by January 2025 as a compliance filing in Dockets UE-220066, et al.

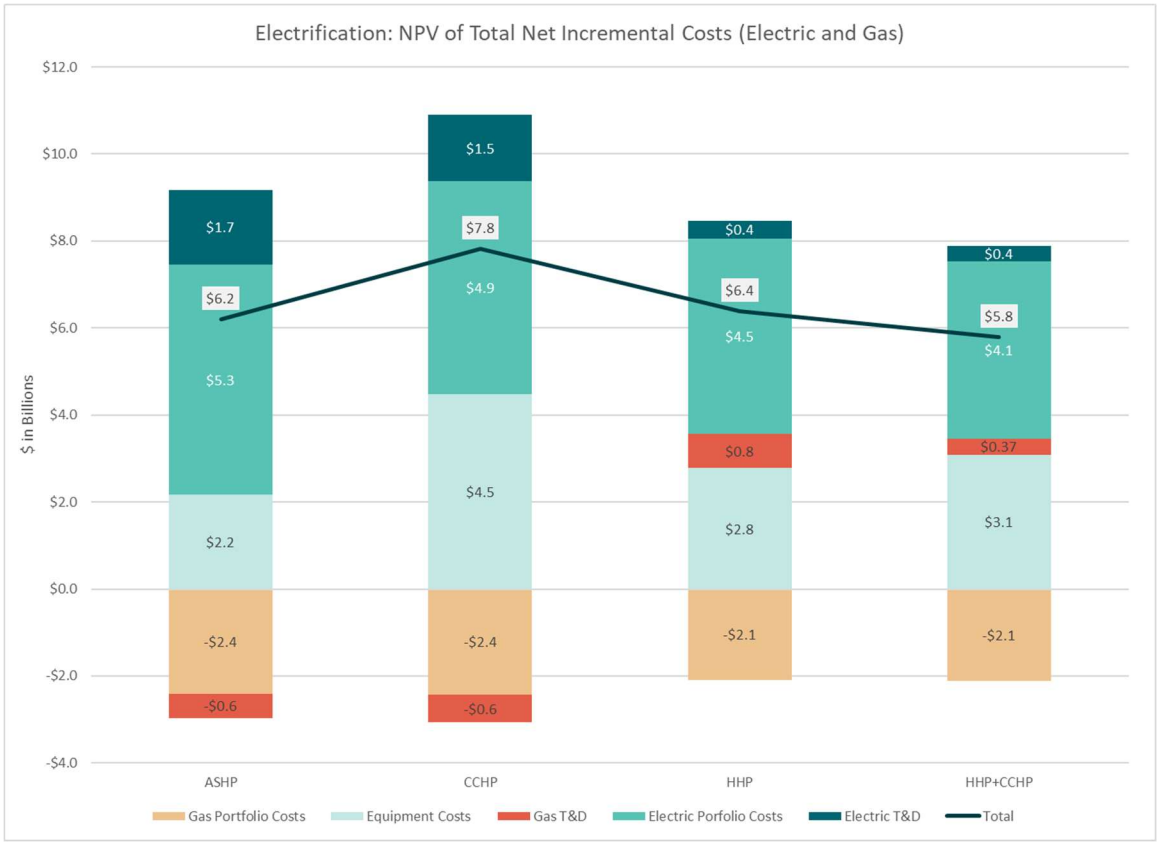
## B. Corrections to PSE's 2023 Decarbonization Study

**Q. Do you have any corrections to the Decarbonization Study in response to Cebulko's testimony?**

A. Yes. I have two corrections to the Decarbonization Study. First, slide 5 of PSE's updated Decarbonization Study (Exh. PJP-3 at Slide 5) incorrectly reflected total appliance and installation costs, instead of incremental costs. *See* Exh. BTC-1T at 25:5-17. This will be corrected in a supplemental filing in that docket, and a copy

of the corrected slide is provided as the third exhibit to my prefiled rebuttal testimony, Exh. PJP-4. The corrected slide (pasted below as Figure 1) shows incremental costs instead of total costs, and correctly pulls from workpapers filed in Docket UE-220066, et al., which contained updated data. Importantly, this correction has a minor impact on incremental costs and does not impact the Decarbonization Study's conclusion that electrification pathways studied are not close to appearing cost effective. Even ignoring appliance and installation costs altogether, abandoning billions of dollars of infrastructure that provides a significant portion of the energy needed for buildings, and replacing it with significant investments in new electric infrastructure will be expensive.

**Figure 1 – Corrected Slide 5 from PSE's Decarbonization Study**




**Q. What is your second correction to the Decarbonization Study?**

A. Second, in correcting slide 5, I noticed that slide 7 also needed to be updated to correctly pull from the workpapers filed in Docket UE-220066, et al., which contained updated data. This will also be corrected in a supplemental filing in that docket, and a copy of the corrected slide 7 is provided in Popoff, Exh. PJP-4.

**Q. Do either of these corrections change the conclusions in the Decarbonization Study or otherwise show that the Decarbonization is fundamentally flawed?**

A. No. The intent of both slides was to show how incremental costs compare with incremental benefits in each scenario. Slide 7 just had the additional information

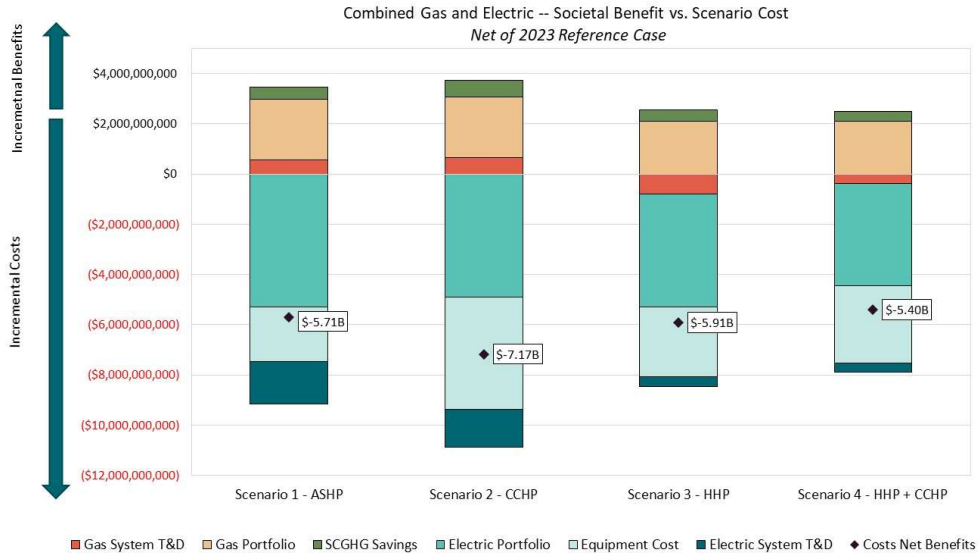
relating to social cost of greenhouse gas ("SCGHG") benefits. Even with the corrections, the Decarbonization Study shows the benefits of electrification under the four scenarios examined are significantly smaller than the incremental costs.

Below, Figure 2 summarizes the total, corrected incremental costs and incremental benefits for each scenario, while also taking into account SCGHG benefits. So for example, in Scenario 1, incremental costs—which include electric portfolio costs, incremental electric system transmission and distribution costs, and incremental appliance and installation costs—total just over negative $9 billion. On the benefit side, incremental benefits related to gas supply savings, gas transmission and distribution savings, and savings related to emissions using the SCGHG calculation, total under $4 billion. Thus, in Scenario 1, incremental benefits minus incremental costs equals -$5.71 billion.

Scenarios 3 and 4 are slightly different when it comes to incremental benefits. In those scenarios, gas transmission and distribution becomes an incremental cost rather than a benefit, because the gas system was assumed to continue to grow, whereas the reference case had almost no gas growth. In particular, all new gas customers were assumed to have heat pumps with natural gas furnace as the supplemental/back-up heat, so incremental gas transmission and distribution costs are higher. Figure 2, which reflects the corrections made, illustrates exactly what the Decarbonization Study showed—i.e., that all the electrification scenarios had

incremental costs more than twice the incremental benefits, including the benefits of emission reduction using the SCGHG calculation.

**Figure 2 – Summary of Incremental Costs vs. Incremental Benefits**




## C. FRAMEWORK OF PSE'S 2023 DECARBONIZATION STUDY

**Q. What was the framework of PSE's Decarbonization Study?**

A. As noted above, the Decarbonization Study's framework was the same as the 2021 study—just with updated assumptions. Thus, it examined four decarbonization pathways against a reference scenario. The primary focus was to examine four different ways of electrifying space heat loads, though other end-uses were electrified over time as well. Scenarios 1 and 2 examined converting space heat from gas furnaces to all electric heat pumps. The primary difference is that Scenario 1 assumed standard air-source heat pumps whereas Scenario 2 assumed cold climate heat pumps, to examine the differences in energy and

capacity impacts between the two kinds of appliances. Both types of heat pumps rely on electric resistance for supplemental or back-up heat when the temperature outside is too cold for the heat pump to maintain a target temperature or when the heat needs to ramp faster than the heat pump can adjust interior temperatures. Scenarios 3 and 4 were different in that they assumed the supplemental/back-up heat was provided by gas furnaces instead of resistance heat, which significantly reduces peaks on the electric system. Scenario 3 assumed standard air source heat pumps with natural gas as the supplement/back-up heating source and Scenario 4 assumed standard air source heat pumps with natural gas for supplemental/back-up heat for existing customers. New customers were electrified with a cold climate heat pump.

**Q. Do you agree that the reference case is not a viable option and, therefore, the framework is fundamentally flawed?**

A. No, Cebulko claims that the Decarbonization Study is fundamentally flawed because the reference scenario is not a feasible alternative against which electrification costs and benefits should be compared because the reference scenario does not include electrification. *See, e.g.*, Cebulko, Exh. BTC-1T at 12:9-13:9. But the reference scenario is identified in PSE's current 2023 Gas Integrated Resource Plan and 2023 Electric IRP Progress report, which were developed pursuant to the formal integrated resource planning processes. Further, the purpose of the Decarbonization Study was to build on the 2021 study with more up-to-date assumptions regarding efficient CCHPs—to perform this comparative

analysis and comply with Stipulation O, PSE was required to retain a reference case. As performed, the Decarbonization Study allows the reader to examine the cost effectiveness of electrification in the four scenarios examined, which provides important information that may help inform the Commission as it considers some of the policy considerations highlighted later in my testimony.

**Q. Do you agree that the reference scenario is not viable because it fails to comply with the Climate Commitment Act ("CCA")?**

A. No. Cebulko posits that the reference scenario fails to comply with the intent of the CCA because it relies on purchasing additional allowances through the containment reserve action at or near ceiling price.[4] But as Cebulko acknowledges, nothing in the CCA requires emission reductions, nor does it prohibit reliance on the reserve auction allowances; the CCA requires covered entities, such as PSE, to purchase compliance instruments (subject to a cap on available compliance instruments that decreases each year) to create market forces that will encourage covered entities to invest in decarbonization efforts. The Department of Ecology must provide allowances needed by gas utilities from its allowance reserve at the ceiling price. And the updated Decarbonization Study demonstrates that electrification is a very costly way to reduce emissions, so it may be more cost effective for PSE's gas customers to pay for allowances than fund electrification. However, PSE does not intend for its long-term strategy to rely exclusively on purchase of compliance instruments; PSE recognizes that

[4] Exh. BTC-1T at 13:10-17:4.

compliance with the CCA will require complex and multifaceted decarbonization efforts.

If anything, the charts showing forecast emissions that Cebulko points to (*see* Exh. BTC-1T at 14, Figures 3 and 4)—which are excerpted from PSE's 2023 Gas Integrated Resource Plan—highlight the importance of linkage in the CCA. These charts indicate that the Department of Ecology may have to issue allowances from its reserve to ensure gas utilities have adequate allowances without electrification, which does not appear cost effective relative to the social cost of greenhouse gases, as described in my testimony below. Other gas utilities in Washington have shown similar results. Significantly increasing the supply of allowances while still ensuring emission reductions by linking to a larger market will be important. Please refer to the Prefiled Rebuttal Testimony of Matt Steuerwalt, Exh. MS-4T for additional response regarding electrification in relation to CCA compliance.

**Q. Was the Decarbonization Study intended to support the development of a general electrification program?**

A. No, the analysis in the Decarbonization Study does not specifically recommend any specific electrification efforts nor does it identify an optimal decarbonization pathway. Instead, it identifies policy issues that will likely inform development of a general electrification program. For example, as noted above, the Decarbonization Study shows that electrifying gas end-uses does not appear to be cost effective, relative to the environmental benefits created.

The Decarbonization Study also suggests that some type of intervention or incentive may be needed to encourage or require customers to replace gas appliances with electric ones. But who should pay for those incentives is a policy issue that is not addressed. There are various funding sources that could be available—each raises different bill impact, cost shifting, and other considerations. For example, funding could come from the Department of Ecology's CCA fund, which is funded through existing gas customers and other covered entities paying for allowances. Another alternative is for gas utility customers to pay for such incentives with consigned allowance revenue while it is available and/or through other charges. This would require non-participating gas customers to prepay for CCA allowance costs that another customer will not incur, creating intraclass cost shifting and possibly interclass cost shifts as well. The same cost shifting happens with gas energy efficiency programs, where non-participating gas customers pay for subsidies given to participating customers. However, such programs are generally cost effective (aside from specific low-income programs that have a lower benefit-to-cost ratio). It is unknown if the Commission will find cost shifting of this kind reasonable in the case of electrification, which does not appear to be cost effective based on the updated Decarbonization Study. It is also possible that the incumbent electric utility would pay a portion of customer incentives. To the extent the electric utility and its customers may be benefiting from the higher load, it may be reasonable for that electric utility's customers to subsidize such conversions, thereby mitigating

or avoiding any cost shifting equity concerns. Some combination of these three funding sources would be possible as well.

As another example, the Decarbonization Study found that as gas sale volumes decrease, non-participating customers' bills increased as system volumes fall but common costs remain the same (such as maintaining the delivery system to get natural gas to the service line connected to the meter on the customer's home). Again, this same situation arises with gas energy efficiency programs, but such programs are generally cost effective. How to, and whether to, mitigate this cost shifting is an important consideration for the Commission in developing a general electrification program, but is a policy issue not addressed in the Decarbonization Study.

Thus, while Decarbonization Study provides important information relating to electrification, it was not intended to identify a specific electrification program, nor does it address important policy issues that should be addressed in a general electrification strategy, including—for example—the precise role that cost-effectiveness, cost-shifting, and incentives will play in developing such a strategy.

**Q. Are there any other reports or planning processes that will inform a general electrification strategy?**

A. Yes. As noted, PSE has not completed its Targeted Electrification Pilot reporting nor its Targeted Electrification Strategy, as required by Stipulation O. Further, PSE has begun work on its 2027 Integrated System Plan ("ISP"), which replaces

PSE's IRP requirements per the newly enacted Electric Utility Resource Plans law, RCW 19.280 (HB 1589). PSE anticipates its 2027 Integrated System Plan will include additional information the Commission find helpful as it considers various policy issues relevant to developing general electrification programs. The Commission is still in the process of developing rules relating to Integrated System Plans (*see* Docket UE-190698), so details will evolve as the Commission progresses through its rulemaking.

Importantly, the Integrated System Plan process will include assessment of information and elements that Cebulko has simply slotted into his general electrification proposal without the benefit of extensive examination, public process, stakeholder engagement, nor the Commissions guidance or rulemaking. For example, the process will include developing different emission reduction targets and fully examining how those scenarios will impact customer strategies, delivery and energy supply planning, and the interaction between gas and electric systems. It will also include forecasting the impacts to customer rates for customers who electrify their end uses to help determine the level of incentives, if any, that will be required to incentivize customers to replace gas appliances with electric ones. The ISP will also include forecasting impacts to bills for gas and electric customers that are not participating in conversion programs to inform the Commission in developing policies to address cost shifting, should the Commission determine such policies are needed.

In sum, PSE anticipates that development and approval of its Integrated System Plan will provide the Commission and other parties with significant amounts of information about the commercial feasibility and cost impacts to customers that is missing from this case, though the ISP alone cannot resolve all the policy issues that may be identified. In the meantime, the Company has proposed a Targeted Electrification Pilot Phase 2, which is addressed in the prefiled direct and rebuttal testimony of John Mannetti, Exhs. JM-1T and JM-4T.

## D. ASSUMPTIONS AND METHODS IN PSE'S 2023 DECARBONIZATION STUDY

**Q. Do you agree with Cebulko's suggestion that for purposes of PSE's CCA compliance, evaluating electrification efforts based on utility program costs would be reasonable?**

A. No. Cebulko's claim that the Commission applies the utility cost test as the primary cost test for gas energy efficient programs is not correct with respect to PSE. *See* Cebulko, Exh. BTC 25:18-26:11. PSE has reflected more of a total resource cost test approach, not a utility cost test. Specifically, PSE has included the 10 percent regional preference to discount measure costs in the Conservation Potential Assessment ("CPA") since its 2015 Gas Utility IRP which informs program planning. Additionally, per RCW 80.28.380, gas utilities are required to reflect the SCGHG in planning for gas energy efficiency programs. Including the regional preference and externalities associated with greenhouse gas emissions is not an application of the utility cost test. Even prior to incorporating the regional

preference adjustment to measure costs in the CPA and including the SCGHG for conservation planning, PSE's analysis looked at the full measure cost to determine cost effectiveness, not just the part of the measure cost paid by PSE.

It is not clear that applying the utility cost test to a general electrification program is appropriate without further guidance. For example, if electrification is not cost effective from a societal perspective but is implemented through a utility cost-test approach, the Commission may want to consider the kinds of cost shifting equity concerns described above.

**Q. Do you agree with Cebulko's testimony that PSE's assumptions relating to equipment conversion in the Decarbonization Study portray the cost of electrification higher than it actually is?**

A. No. I addressed the correction on incremental appliance and installation costs above. And Cebulko's concerns relating to heat pumps, baseline installation, and gas furnace costs are either incorrect or misunderstand the data, and I address each below:

Heat Pump Costs. Cebulko claims that heat pump costs "may" be inflated. *See* Cebulko, Exh. BTC-1T at 26:12-28:2 (comparing Figure 9 and Figure 10). They were not. Heat pump and related installation cost forecasts were obtained from Cadmus, which provided 2030 figures at a 2.5 percent rate of inflation. That is why the numbers in Figure 10 are higher than the Figure 9, which showed estimated Inflation Reduction Act reduction on appliance costs for those low-

income customers that qualify. Table 1 below illustrates how these values come together and tie to the $20,093 for the air source heat pump shown in Cebulko's Figure 9, for customers that do not receive low income subsidies shown on Cebulko's Figure 10:

**Table 1. Base Appliance costs with inflation and conversion costs**

| End Use | Equation | Total |
|---|---|---|
| Base Cost Heat pump (2022 dollars) + installation cost | $14,800 + $1,668 | $16,468 |
| Convert to 2030 dollars | x 2.5^8 | $20,093 |

Baseline Installation Costs. Cebulko claims that, even if PSE correctly performed its calculation on incremental cost, the baseline installation costs may be too low. *See* Cebulko, Exh. BTC-1T at 28:3-29:2. It is not clear if he is referring to appliance and installation costs, or just installation costs. Regardless, the appliance and installation costs assumption from Cadmus were reasonable. Moreover, Cebulko's hypothetical example of how a customer might choose to replace a heat pump for cooling, rather than upon burnout of an existing heating appliance, is a single example that has not been shown to be the norm, nor does he mention that some conversions to electric heat could be significantly more expensive than the average assumption from Cadmus, thus potentially requiring a higher incentive.

Gas Furnaces. Cebulko speculates that gas furnaces were undersized in the Decarbonization Study. *See* Cebulko, Exh. BTC-1T at 28:11-13. They were not.

The gas furnace used in a new hybrid heating system is the same size gas furnace used on a stand-alone basis. In hybrid heating systems, the gas furnace will heat the customer's home when the heat pump cannot, so the furnace needs to be sized to heat the customer's home.

**Q. Do you agree with Cebulko's testimony that PSE's possible inputs and assumptions for calculating electric portfolio costs in the Decarbonization Study portray the cost of electrification higher than it actually is?**

A. No, the electric portfolio results are reasonable, when viewed holistically. Electric portfolio analysis is very complex and best discussed informally, where parties can ask questions and discuss issues. PSE hosted such meetings during development of the Decarbonization Study. As noted, JEA representatives did not express concerns on the topics that are addressed in Cebulko's testimony. For this reason, I will attempt to address Cebulko's testimony, although his concerns are not always entirely clear.

Reduced CCA Compliance Costs. Cebulko appears to speculate that none of the four electrification scenarios considered reduction to CCA compliance solutions included in the reference case. *See* Cebulko, Exh. BTC-1T at 29:7-17. But in the electric portfolio modeling for the Decarbonization Study, CCA costs were treated as a variable cost that is applied to fossil fuel generation and unspecified market purchases that are used to meet load. Thus, electric portfolios that have less fossil fuel consumption and less unspecified market purchases to meet load will have lower CCA compliance costs.

Electric System Expansion Costs. Cebulko claims that electric system expansion costs may be inflated because he does not understand differences among resources selected in the different scenarios. *See* Cebulko, Exh. BTC-1T 29:18-31:2. He raises two results that he finds "illogical"—I will explain each below. First, he claims that it is "not logical" that scenarios 3 and 4 include the addition of "relatively expensive" new nuclear resources. *Id*. But in scenarios 3 and 4, electric loads are increasing while peak loads are being covered by the natural gas system, so load shapes are flatter. It is not surprising to see a baseload, non-emitting generation source like nuclear being part of the least cost portfolio in those scenarios. PSE's resource planning model (Aurora) takes into account loads and load shapes, generation and generation shapes/dispatchability, along with fixed costs of new resources and variable costs of existing and new resources. Nuclear was selected in scenarios 3 and 4 as there is still a large increase in annual energy, but less of an emphasis on peak. While the capital cost of nuclear is far higher than a peaking unit, there are dispatch limitations on the peakers and high dispatch costs. With the large increase in energy need as a key factor as compared to peak impacts in scenarios 3 and 4, small modular reactors become more economic as a baseload resource.

Second, Cebulko claims that it is "logic-defying" that the four electrification scenarios include biodiesel peaker plant additions that are 2-5 time greater than those included in the reference portfolio. *See* Cebulko, Exh. BTC-1T at 30:5-12. But Table 3 of Cebulko's testimony (Exh. BTC-1T at 30, Table 3) is not a complete representation of peakers being added. The planning model had two

kinds of peakers to choose from: one fueled by a blend of natural gas and hydrogen that increased in hydrogen over time, but for a very limited number of hours, and the another that was the same peaker that could only run on biodiesel, again for a limited number of hours. The details between which type of peaker is driven by the different fuel limitations and load shapes, along with other changes in the portfolio.

When looking at both types of peakers together, the results appear quite reasonable in that the addition of peakers met an increase in peak load. Table 2, below, illustrates the combined additional peaker capacity of both types, along with the additional peak loads relative to the reference case. This table shows that the incremental peaker additions are reasonable with respect to the higher loads.

**Table 2. Peaker Capacity Compared with Winter Peak Load**
**2045 Capacity (MW) - Net of Reference Case**

| | Scenario 1 ASHP | Scenario 2 CCHP | Scenario 3 HHP | Scenario 4 HHP + CCHP |
|---|---|---|---|---|
| New CETA-qualifying Peaking Capacity | 2,004 | 1,640 | 511 | 382 |
| Winter Peak Load | 2,027 | 1,731 | 435 | 390 |

Market Purchases. Finally, Cebulko claims that there is a discrepancy in the level of market purchases between the reference case and the four electrification scenarios. *See* Cebulko, Exh. BTC-1T at 31:3-32:7. But the volume of market

purchases is dictated by the modeled loads, dispatch costs, hourly output from intermittent resources, and power prices in each hour. The electrification scenarios, when compared to the reference case, exhibit very different load shapes and volumes. Given these differences, the hourly modeling dynamics, including the volume of market interactions, will differ.

Figure 11 in Cebulko's testimony (Exh. BTC-1T at 31), only illustrates market purchases from Scenario 4 (hybrid heating for existing customers and new customer with cold climate heat pumps) and the reference case, which amplifies a difference that is actually insignificant when considering the total load. Table 3 below shows how total generation by category plus market purchases, minus storage injections and market sales, relates to annual loads for 2027 and 2045. The change in market purchases from Scenario 4 to Scenario 1 is 1,847,517 – 2,459,336 = -591,820 MWh. That is only a 2.5% change, relative to the total load for the reference case of 23,362,092 MWh.

**Table 3. Annual Energy by Resource Type (MWh)**

| 2027 | | | | | |
|---|---|---|---|---|---|
| | **Reference** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** |
| Existing Resources | 15,848,507 | 15,808,278 | 14,973,099 | 15,220,705 | 14,998,283 |
| New Generating Resources | 5,800,677 | 6,517,379 | 8,282,499 | 7,518,494 | 8,007,990 |
| New Storage | -177,874 | -138,697 | -139,436 | -156,030 | -139,169 |
| Market Purchases | 2,459,336 | 2,106,298 | 1,859,965 | 2,011,271 | 1,867,517 |
| Market Sales | -568,555 | -482,677 | -1,160,902 | -812,947 | -958,347 |
| Total Resources (net sales) | 23,362,092 | 23,810,580 | 23,815,224 | 23,781,492 | 23,776,274 |
| Total Load | 23,362,092 | 23,810,580 | 23,815,224 | 23,781,492 | 23,776,274 |
| Delta | 0 | 0 | 0 | 0 | 0 |

| 2045 | | | | | |
|---|---|---|---|---|---|
| | **Reference** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** |
| Existing Resources | 7,976,307 | 6,803,900 | 6,766,262 | 6,538,439 | 6,582,752 |
| New Generating Resources | 28,689,392 | 33,958,398 | 33,297,193 | 34,394,057 | 34,128,781 |
| New Storage | -307,488 | -343,046 | -325,745 | -339,201 | -324,300 |
| Market Purchases | 994,910 | 2,021,076 | 2,072,825 | 1,688,521 | 1,709,826 |
| Market Sales | -4,951,966 | -3,542,236 | -3,580,274 | -3,822,908 | -3,696,500 |
| Total Resources (net sales) | 32,401,154 | 38,898,092 | 38,230,261 | 38,458,908 | 38,400,559 |
| Total Load | 32,401,154 | 38,898,092 | 38,230,261 | 38,458,908 | 38,400,559 |
| Delta | 0 | 0 | 0 | 0 | 0 |

Changes of this magnitude are not unreasonable when hourly loads and hourly generation between the scenarios are so different. It is not an indicator that the underlying portfolio analysis is flawed, rather it is something one could investigate further to fully understand the details; however, such investigation has such little impact, it would not be worthwhile. As noted above, abandoning billions of dollars of fully functioning natural gas infrastructure to rebuild it with electric infrastructure should be expected to be a costly endeavor.

**Q. Do you agree that gas portfolio benefits due to avoided costs on the gas system "may be underestimated" due to an assumption that new customers installing cold climate heat pumps would still connect to the gas system?**

A. No. Cebulko makes this claim at Exh. BTC-1T at 32:8-17. But Scenarios 3 and 4 in the Decarbonization Study were intended to examine the impact of electric heat pumps that use natural gas for the supplemental/peaking loads, rather than electric resistance heat, which provides supplemental heat in an all-electric heat pump.

That is, the scenarios were specifically intended to examine the benefits to the electric system by leaving the growth in peak heat to the gas utility. Since those scenarios were intended to examine the impacts of continuing to grow the gas system, it was reasonable to assume end-uses such as cooking, fireplaces, and BBQs would also continue to be gas appliances. Cebulko is correct that expansion of the gas system could be avoided altogether if all new customers were fully electrified. *See* Cebulko, Exh. BTC-1T at 32:16-17. Those results are shown in Scenarios 1 and 2 of the Decarbonization Study.

## III. CONCLUSION

**Q. Does that conclude your prefiled rebuttal testimony?**

A. Yes, it does.