

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

**BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

**WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION,**

Complainant,

v.

PUGET SOUND ENERGY,

Respondent.

**Docket UE-240004
Docket UG-240005
(consolidated)**

In the Matter of the Petition of

PUGET SOUND ENERGY

**For an Accounting Order Authorizing
deferred accounting treatment of
purchased power agreement expenses
pursuant to RCW 80.28.410**

**Docket UE 230810
(consolidated)**

PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF

PHILLIP J. POPOFF

ON BEHALF OF PUGET SOUND ENERGY

**REVISED VERSION
October 28, 2024**

SEPTEMBER 18, 2024

PUGET SOUND ENERGY

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

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PUGET SOUND ENERGY

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1 **PUGET SOUND ENERGY**

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

4 **I. INTRODUCTION**

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

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

10 **Q. Please describe your background and professional qualifications.**

11 A. I have worked in the energy utility sector for over 30 years. I worked at the
12 Virginia State Corporation Commission for two years, the Washington Utilities
13 and Transportation Commission for three years, and at PSE for 27 years.
14 Currently, I lead PSE’s Integrated Resource Planning (“IRP”) and Load
15 Forecasting teams. An exhibit detailing my professional qualifications is provided
16 as Exhibit PJP-2.

17 **Q. What is the purpose of your rebuttal testimony?**

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

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

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

6 A. Yes. I will first give an overview of the process for developing the
7 Decarbonization Study, which was to update assumptions from a prior study in
8 order to examine the impacts of different gas utility electrification pathways to the
9 electric system, gas system, costs, and emissions. Next, I will explain two minor
10 corrections to the Decarbonization Study and explain why those corrections do
11 not change conclusions in the Decarbonization Study nor render it fundamentally
12 flawed. Finally, I will explain why PSE’s Decarbonization Study, filed in Dockets
13 UE-220066, et al., was generally framed properly, and relied on correct and
14 reasonable assumptions and methods in light of its purpose, contrary to Cebulko’s
15 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”)

1 **II. PSE’S 2023 DECARBONIZATION STUDY**

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

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

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

7 A. I agree with Cebulko’s overall recommendation that the Washington Utilities and
8 Transportation Commission (“Commission”) not rely on PSE’s Decarbonization
9 Study to develop a general electrification program. *See* Cebulko, Exh. BTC-1T at
10 11:3-5. The Decarbonization Study was not intended to support development of a
11 general electrification program, though it does include useful information as
12 policies, strategies, and programs are developed in the future. Additionally, I
13 agree with Cebulko that total appliance and installation costs were incorrectly
14 displayed as incremental costs relative to the reference case in two slides of the
15 Decarbonization Study and correct that mistake, as explained further below.

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

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

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

3 **A. Process For Developing PSE’s 2023 Decarbonization Study**

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

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

12 As part of the settlement in PSE’s 2022 general rate case, PSE agreed to file an
13 update to its 2021 decarbonization study. The specific requirements for the
14 updated study were provided for in “Stipulation O” of the settlement agreement.²
15 In particular, Stipulation O stated: “PSE’s updated decarbonization study will
16 build off the gas decarbonization study prepared for PSE by E3 with more up-to-
17 date assumptions regarding Cold Climate Heat Pumps (“CCHPs”) for targeted
18 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.*

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

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

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

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

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

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

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

5 PSE filed its Decarbonization Study on December 21, 2023 in Docket UE-
6 220066, *et al.*, in compliance with Stipulation O.

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

9 A. Yes. Per Stipulation O, PSE is taking the key findings from the Decarbonization
10 Study and incorporating them into a Targeted Electrification Strategy as well as
11 the Company's future planning processes. PSE intends to file its report
12 summarizing the results of the Targeted Electrification Pilot and its Targeted
13 Electrification Strategy by January 2025 as a compliance filing in Dockets UE-
14 220066, *et al.*

15 **B. Corrections to PSE's 2023 Decarbonization Study**

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

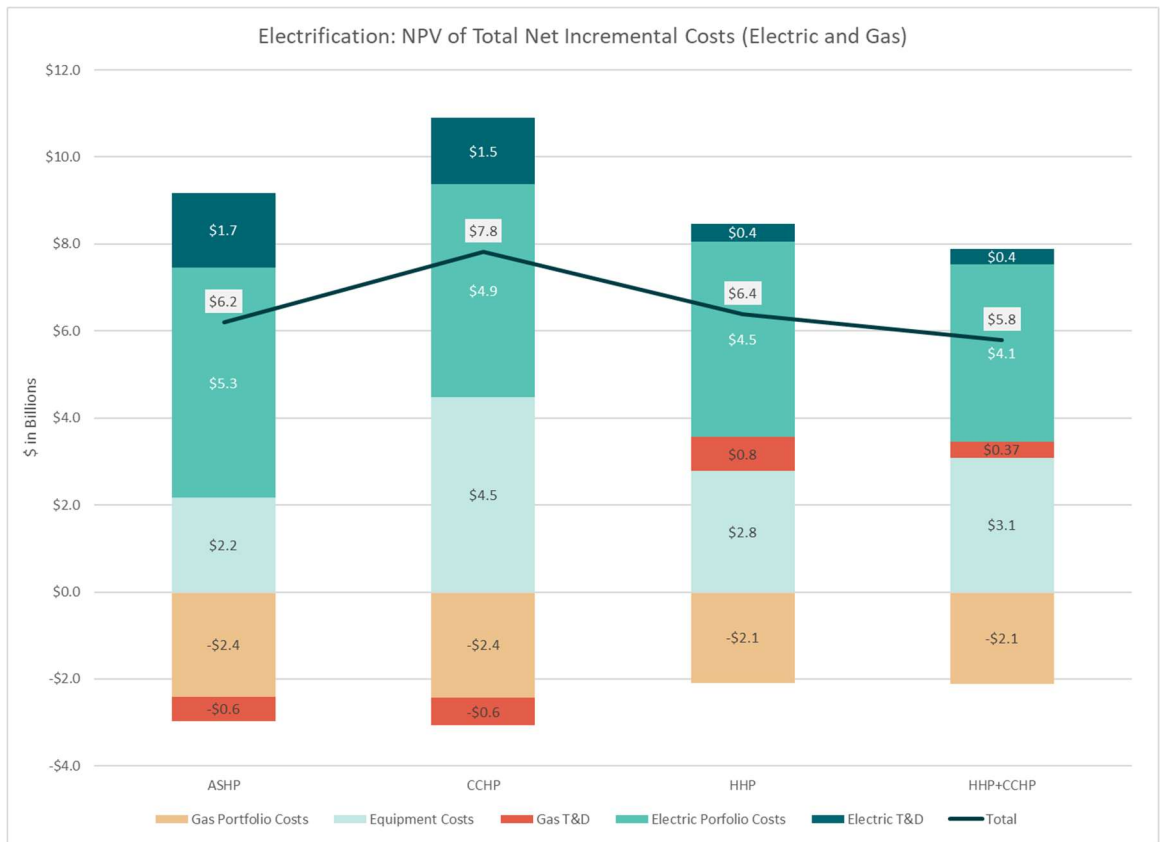
18 A. Yes. I have two corrections to the Decarbonization Study. First, slide 5 of PSE's
19 updated Decarbonization Study (Exh. PJP-3 at Slide 5) incorrectly reflected total
20 appliance and installation costs, instead of incremental costs. *See* Exh. BTC-1T at
21 25:5-17. This will be corrected in a supplemental filing in that docket, and a copy

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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.

1

Figure 1 – Corrected Slide 5 from PSE’s Decarbonization Study



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3

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

4

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.

8

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

10

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

11

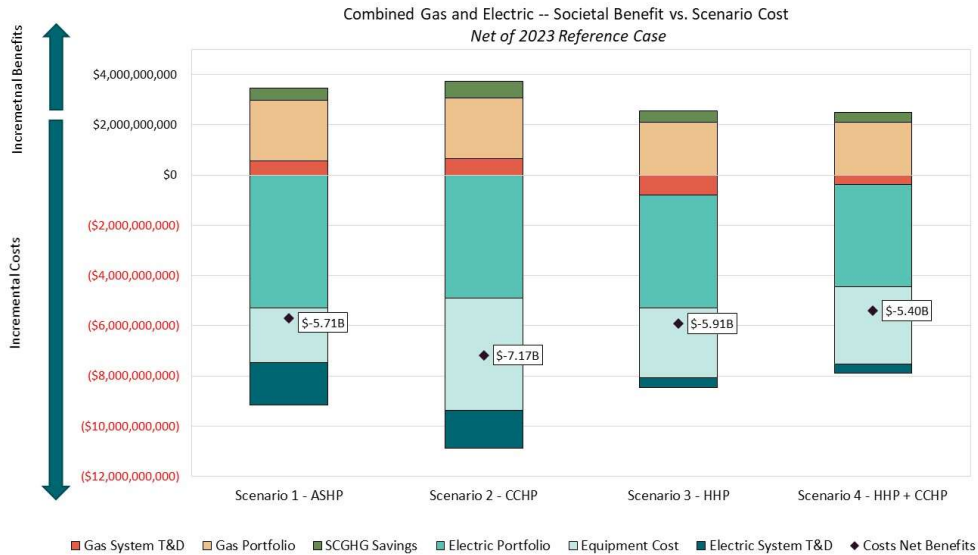
1 relating to social cost of greenhouse gas (“SCGHG”) benefits. Even with the
2 corrections, the Decarbonization Study shows the benefits of electrification under
3 the four scenarios examined are significantly smaller than the incremental costs.

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

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

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

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



4
5 **C. FRAMEWORK OF PSE’S 2023 DECARBONIZATION STUDY**

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

7 A. As noted above, the Decarbonization Study’s framework was the same as the
8 2021 study—just with updated assumptions. Thus, it examined four
9 decarbonization pathways against a reference scenario. The primary focus was to
10 examine four different ways of electrifying space heat loads, though other end-
11 uses were electrified over time as well. Scenarios 1 and 2 examined converting
12 space heat from gas furnaces to all electric heat pumps. The primary difference is
13 that Scenario 1 assumed standard air-source heat pumps whereas Scenario 2
14 assumed cold climate heat pumps, to examine the differences in energy and

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

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

14 A. No, Cebulko claims that the Decarbonization Study is fundamentally flawed
15 because the reference scenario is not a feasible alternative against which
16 electrification costs and benefits should be compared because the reference
17 scenario does not include electrification. *See, e.g.*, Cebulko, Exh. BTC-1T at 12:9-
18 13:9. But the reference scenario is identified in PSE's current 2023 Gas Integrated
19 Resource Plan and 2023 Electric IRP Progress report, which were developed
20 pursuant to the formal integrated resource planning processes. Further, the
21 purpose of the Decarbonization Study was to build on the 2021 study with more
22 up-to-date assumptions regarding efficient CCHPs—to perform this comparative

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

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

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

⁴ Exh. BTC-1T at 13:10-17:4.

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

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

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

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

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

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

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

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

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

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

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

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

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

8 **D. ASSUMPTIONS AND METHODS IN PSE’S 2023 DECARBONIZATION**
9 **STUDY**

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

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

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

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

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

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

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

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

5 **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	$\times 2.5^8$	\$20,093

6
7 Baseline Installation Costs. Cebulko claims that, even if PSE correctly performed
8 its calculation on incremental cost, the baseline installation costs may be too low.
9 *See* Cebulko, Exh. BTC-1T at 28:3-29:2. It is not clear if he is referring to
10 appliance and installation costs, or just installation costs. Regardless, the
11 appliance and installation costs assumption from Cadmus were reasonable.
12 Moreover, Cebulko's hypothetical example of how a customer might choose to
13 replace a heat pump for cooling, rather than upon burnout of an existing heating
14 appliance, is a single example that has not been shown to be the norm, nor does he
15 mention that some conversions to electric heat could be significantly more
16 expensive than the average assumption from Cadmus, thus potentially requiring a
17 higher incentive.

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

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

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

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

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

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

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

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

7 When looking at both types of peakers together, the results appear quite
 8 reasonable in that the addition of peakers met an increase in peak load. Table 2,
 9 below, illustrates the combined additional peaker capacity of both types, along
 10 with the additional peak loads relative to the reference case. This table shows that
 11 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**

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

12
 13 Market Purchases. Finally, Cebulko claims that there is a discrepancy in the level
 14 of market purchases between the reference case and the four electrification
 15 scenarios. *See* Cebulko, Exh. BTC-1T at 31:3-32:7. But the volume of market

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

6 Figure 11 in Cebulko’s testimony (Exh. BTC-1T at 31), only illustrates market
 7 purchases from Scenario 4 (hybrid heating for existing customers and new
 8 customer with cold climate heat pumps) and the reference case, which amplifies a
 9 difference that is actually insignificant when considering the total load. Table 3
 10 below shows how total generation by category plus market purchases, minus
 11 storage injections and market sales, relates to annual loads for 2027 and 2045.

12 The change in market purchases from Scenario 4 to ~~Scenario 1~~ the reference case
 13 is $1,8467,517 - 2,459,336 = -591,820$ MWh. That is only a 2.5% change, relative
 14 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

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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

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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.

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

9 **III. CONCLUSION**

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

11 A. Yes, it does.