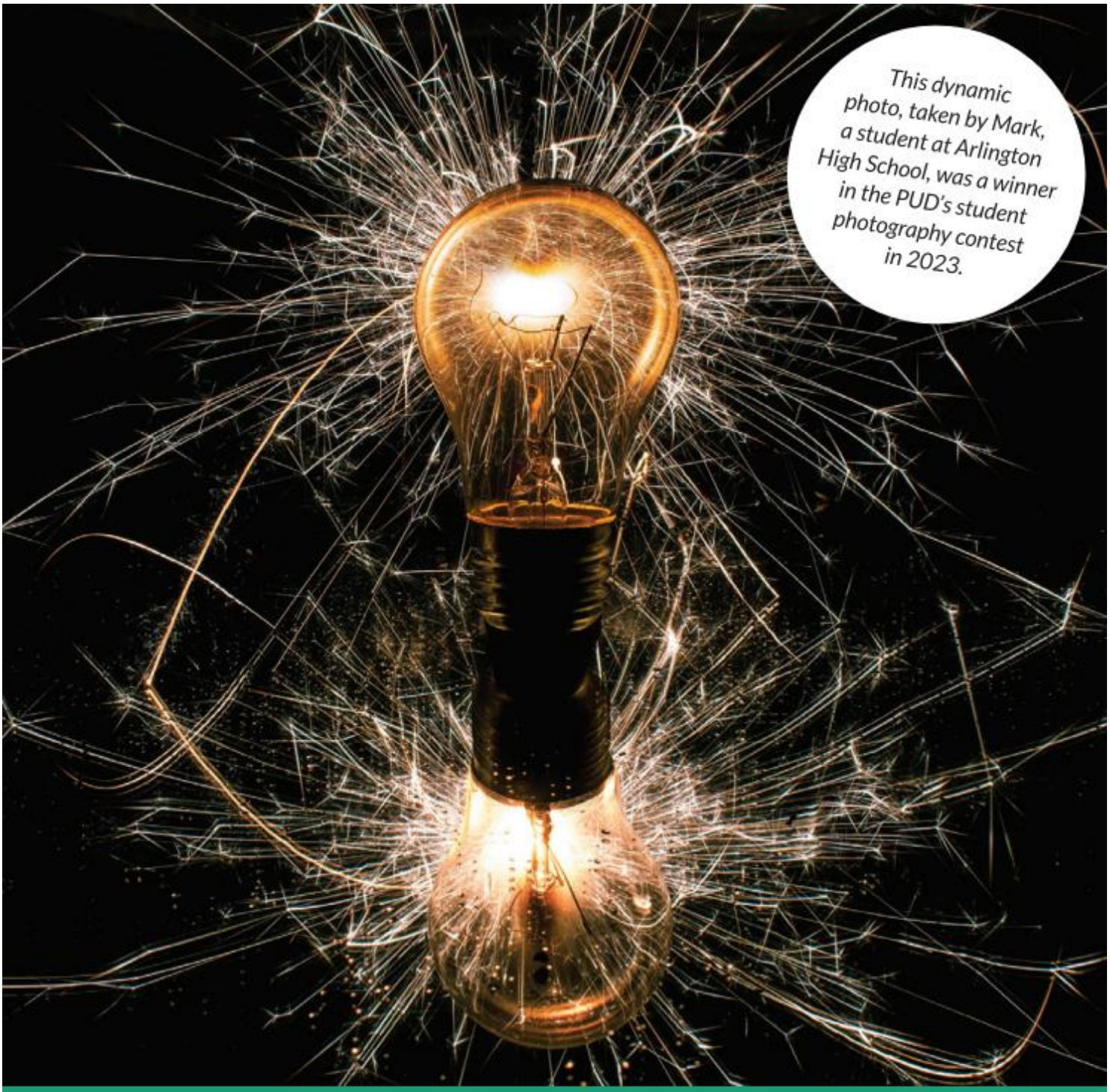

Snohomish PUD 2023 IRP Update

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Contents

IRP Acknowledgements

The Integrated Resource Plan (IRP) process is deliberately collaborative and requires the contributions of subject matter experts across the PUD, the feedback from our customers, and the guidance by the PUD's elected Commissioners to be successful. As a result, the 2023 Update was only possible through the contributions of the following groups.

Our Customers.
PUD staff engage our customers for the questions, comments and feedback on our planning processes and their perspectives. This feedback is invaluable as we seek to shape a resource strategy that meets our customer's needs. There have been many public engagements throughout the development and finalization of the 2023 Update, which are described in more detail in Technical Appendix A. PUD staff thank our customers for their participation, and our opportunity as public servants, to provide safe, reliable, affordable and environmentally sustainable electricity to our community.

Our Elected PUD Commissioners.
Commissioners Sid Logan, Toni Olson, and Dr. Rebecca Wolfe provided regular feedback throughout the IRP process via their active participation in public meetings that sequentially discussed the development of the 2023 Update. Their guidance has shaped the 2023 Update to reflect their perspectives on behalf of their constituents.

The IRP Technical Team.
The PUD utilizes a cross-functional team of subject matter experts to peer review IRP inputs and outputs to ensure the technical soundness of the approach, as well as the appropriateness of the resulting strategy. Members of the Technical Team for the 2023 Update include: Kenn Backholm, Scott Richards, Adam Cornelius, Marie Morrison, Ian Hunter, Jessica Spahr, Alex Chorey, Alexis Dickey, Lauren Way, Kevin Costello, Mike Shapley, Kelly Wallace, Andrew Cox, Ryan Ziegler, Andrew Wilson, Brad Spangler, Adam Lewis, Dawn Presler, Scott Spahr, Christina Leinnewebber, Peter Dauenhauer, John Wallstrom, Michael Coe, Allison Stansberry, Sinh Tran, Felicienne Ng, Charles Hersrud, Doug O'Donnell and Jeff Feinberg.

Our Student Photographer's Great Cover Art.
The cover art for the 2023 Update comes from the 2023 High School Photography contest. The cover photograph was submitted by Mark, then a junior at Arlington High School. The photograph was the Employees' Choice Award winner of the 2023 contest. The 2023 High School Photography Contest was a product of the PUD's education program, which provides STEAM (Science, Technology, Engineering, Art, and Math) curriculum based on Washington State and Next Generation Science Standards to students throughout Snohomish County and Camano Island. More information on the education program can be found at: https://www.snopud.com/community-environment/in-our-communities/education/.

1. Executive Summary

A. Key Updates in the 2023 IRP Update

The 2023 Integrated Resource Plan (IRP) Update is intended to be a narrowly scoped update to the comprehensive 2021 IRP. Comprehensive IRPs are filed every four years, with IRP Updates filed midway between each comprehensive filing. An IRP update typically incorporates only a small subset of variables that have materially changed since the last comprehensive IRP. In a typical IRP update cycle this list of variables is modest and the scale of change is small. Market prices the cost of demand-side and supply-side resources and the load forecast are common factors that need updates.

Contrary to a typical update cycle, the scope and scale of updates in the 2023 Update are large. While the 2023 Update utilizes the same modelling methodology and framework as the 2021 IRP, many variables have seen significant changes and there are additional key questions explored by this update. Important elements reflected in this IRP include the following:

Load Forecast Increase: Changes in state and local policy have increased the electrification portion of the load forecast, resulting in a higher contribution from electric vehicles and a greater expectation of buildings with new or converted electrification of space and water heating. ***The annual average load growth from 2024-2045 is 2.07%, which is up from the 0.96% forecast in the 2021 IRP.*** More discussion is provided in Section 3.

Post-2028 Updates: While the PUD does not have certainty on what Post-2028 Power Product configurations and rates will be, there is increased clarity on the likely allocation of at-cost federal power from BPA. The 2023 Update examined several potential configurations of BPA Products. This preliminary analysis revealed that ***the PUD still prefers to continue as a Block/Slice product customer of BPA,*** but will evaluate all options when more details are available in 2024 and 2025. Further discussion is provided in Sections 3 and 5.

Market Price Forecast Increasing**:** Higher loads, increased market uncertainty, higher natural gas prices, and retiring regional resources has put upwards pressure on market prices, as well as a large band of uncertainty on long-term future market prices. The PUD evaluated four divergent market price environments to identify the lowest cost, lowest risk scenario for its Long-Term Resource Strategy. ***The average annual market price in the Base Case of the 2021 IRP was $35.79/MWh across the study period; in the 2023 Update it is $37.59/MWh.*** More discussion is provided in Section 3.

Supply-Side Resource Costs Decreasing: The Inflation Reduction Act introduced tax credits as high as 50% of capital costs for some clean energy resource investments in some time periods within the study period. ***The effects of the tax credits are modeled explicitly in the 2023 IRP and the impact is a lowering of effective development costs for clean energy resources.*** These lower costs are an opportunity for the PUD. More discussion is provided in Sections 3 and 5.

B. Key Findings

The PUD will seek to meet future needs with clean energy resource investments

The 2023 Update confirms one of the fundamental findings of the 2021 IRP, **that the PUD expects to meet its long-term load service needs by adding only carbon-free energy resources to its power portfolio, which is currently composed of only carbon-free energy resources.** This clean energy strategy has been selected because it has been mathematically shown to provide reliable service at the lowest cost to customers. The expected significant electrification load creates a need to increase the volume of clean energy resources but the core strategy remains intact. This strategy and problem-solving is in alignment with the PUD mission to deliver affordable power to our customer-owners in a safe, environmentally sustainable and reliable manner while successfully navigating complex change in our industry.

The PUD Resource Strategy prioritizes flexibility in a period of industry change

The electric industry is undergoing a period of significant and complex change. The PUD is actively negotiating a long-term contract with BPA expected to provide upwards of 80% of the PUD Power Supply needed after 2028. The region is operationalizing a new Resource Adequacy program that is expected to enhance regional reliability in the Western United States, but which will also introduce new standards for portfolio adequacy. Organized markets are developing which are expected to change the way energy and capacity are traded on wholesale markets. For this reason**, one of the core features of the 2023 Update Resource Strategy is flexibility with a proactive approach.** The Resource Strategy prioritizes making near-term investments that will be effective across BPA Power Products, identifies best-fit long-term investments to be evaluated, and includes consideration of different BPA Power Products. The strategy also establishes an Action Plan, which includes performing due diligence upon procurement efforts that will be triggered once BPA contract and product specifications provide sufficient transparency to substantiate long-term PUD investment.

The PUD will remain a regional leader, and seeks to meet and exceed regulatory requirements

While managing complex change, the PUD will also meet its regulatory compliance obligations. **The resource strategy includes a biennial conservation target of 10.54 aMW that is an increase of 2.56 aMW, or 32%, over the previous biennial conservation target of 7.96 aMW**. **The PUD plans to meet Renewable Portfolio Standard requirements with a mix of renewable resource investments and procurement of Renewable Energy Credits** to achieve the lowest cost of regulatory compliance for customers. **The PUD is still targeting a goal of being 100% clean under the standards set forth by the Clean Energy Transformation Act by 2030**, 15 years ahead of the statutory requirement. While the exact nature and timing of renewable investment will be shaped by the specifics of the Post-2028 BPA Power contract and products, the PUD has contingency plans for regulatory compliance and will remain flexible to meet multiple customer objectives with a commitment to clean energy.

C. *Resource Strategy*

The PUD's Resource Strategy can be viewed as:
(1) Resource actions the PUD will take in the near-term because they are expected to be effective regardless of BPA Power contract and product outcomes and;
(2) Resource actions the PUD expects it would take if the PUD continues to be Block/Slice BPA product customers. The 2023 Update economic analysis has shown Block/Slice to likely be the most cost-effective product to serve customer load across the study period.

Near-Term Resource Strategy

Near-Term Actions can be considered the actions the PUD expects to take in the next 2-3 years to augment its existing resources and serve load cost-effectively.

Cost-Effective Conservation	Time-of-Day Rate Options	Energy Storage	Short-Term Market Contracts	Post-2028 Contracts
•**Cost effective conservation** remains a key component of the PUD's long term resource strategy and provides the PUD with significant value. Conservation has been a consistently sound investment for the PUD for several decades. The analysis from the 2023 Update confirms this value and plans for significant additional investment over the study period. ***The biennial conservation target for 2024-2025 is 10.54 aMW.***	•**Time-of-Day rate options** provide participating customers more control over their bills and allow the PUD to incentivize demand shifts from higher-cost periods to serve to lower-cost periods. The PUD is planning new options for customers in parallel with the roll-out of advanced meters that will make these rate options possible. ***The 2023 Update targets a modest 1aMW of average peak reduction by 2025, in line with forecasts for advanced meter rollouts and customer engagement processes.***	•**Energy Storage** resources position the PUD well under multiple BPA product options: they provide organized market functionality, contribute to resource adequacy needs and reduce transmission risk. ***The 2023 Update assumes the 25MW battery currently undergoing procurement will be online by October 2025. It also suggests that the PUD should be pursuing additional due diligence on potential sites, procurement strategy and distribution system needs for additional storage investments.***	•**Short-term market contracts** serve primarily as a bridge to meet forecast resource-load gaps until long-term demand and supply-side resources come online. Long-term resources and demand-side programs take time to construct, develop, and implement. ***The 2023 Update targets 50MW of additional short-term market contracts from 2024-2026.***	•**PUD staff must negotiate for cost-effective Post-2028 BPA Power Product options** and evaluate the best fit for customer needs. This process began in 2021, and is expected to continue through 2024, with contract execution in 2025. The PUD must remain flexible and open to product alternatives through this process. It is expected that the Block/Slice product works best for the PUD with the information today, but staff will continue evaluating all options.

Mid-to-Late Term Resource Strategy

The PUD must prepare to take additional steps for resource procurement to serve growing load as it negotiates the Post-2028 BPA Power Contract, which is expected to span 2029-2045. Mid-to-Late Term Resource Strategy actions represent the current plan for future resource actions, but it is understood that some or all of them may need to adjust as the PUD negotiates and implements the Post-2028 BPA Power Contract. For example, if a BPA Power Contract provides more clean energy or flexibility, the PUD may need to acquire less clean energy or flexibility, and vice versa.

Conservation	Time-of-Day Rates	Renewables and Clean Energy	BPA Tier 2 Power	Energy Storage
•The PUD will **continue to invest in community conservation programs** to manage load growth. The 2024-2045 conservation outlook estimates a total of 168.34 aMW new conservation by 2045	•**The PUD anticipates growing participation in Time-of-Day Rate offerings.** As the PUD completes the AMI rollout, it is expected that customers will be more familiar with the Rate Options that best fit their needs. These programs provide customers more control over their bills and reduce costs for all customers. The 2023 Update forecasts that programs will provide 30 aMW of Peak energy savings by 2045.	•**To meet growing energy demand, the PUD will need to invest in additional renewable and clean energy projects.** The PUD does not plan to invest in any carbon emitting resources. The 2023 Update expects a mix of wind energy, solar energy, and other clean energy sources. but the best-fit clean resources will ultimately be identified by competitive procurement processes. The scale of procurement is dependent on the BPA Post-2028 Power Contract.	•**The PUD expects to be eligible to procure additional energy through BPA's Tier 2 power product offering.** The PUD is primarily interested in Tier 2 products that are supported by clean physical resources and are expected to provide stable costs. The PUD expects to procure not less than 200aMW of Tier 2 resources by 2045, though this volume is dependent on the Post-2028 BPA Power contract.	•**The PUD expects to add additional energy storage resources** to its portfolio over the long-term in order to integrate renewables, add portfolio flexibility, mitigate transmission risk, and provide market risk mitigation. The volume of energy storage procured is dependent on the Post-2028 BPA Power contract.

Resource Strategy Highlights

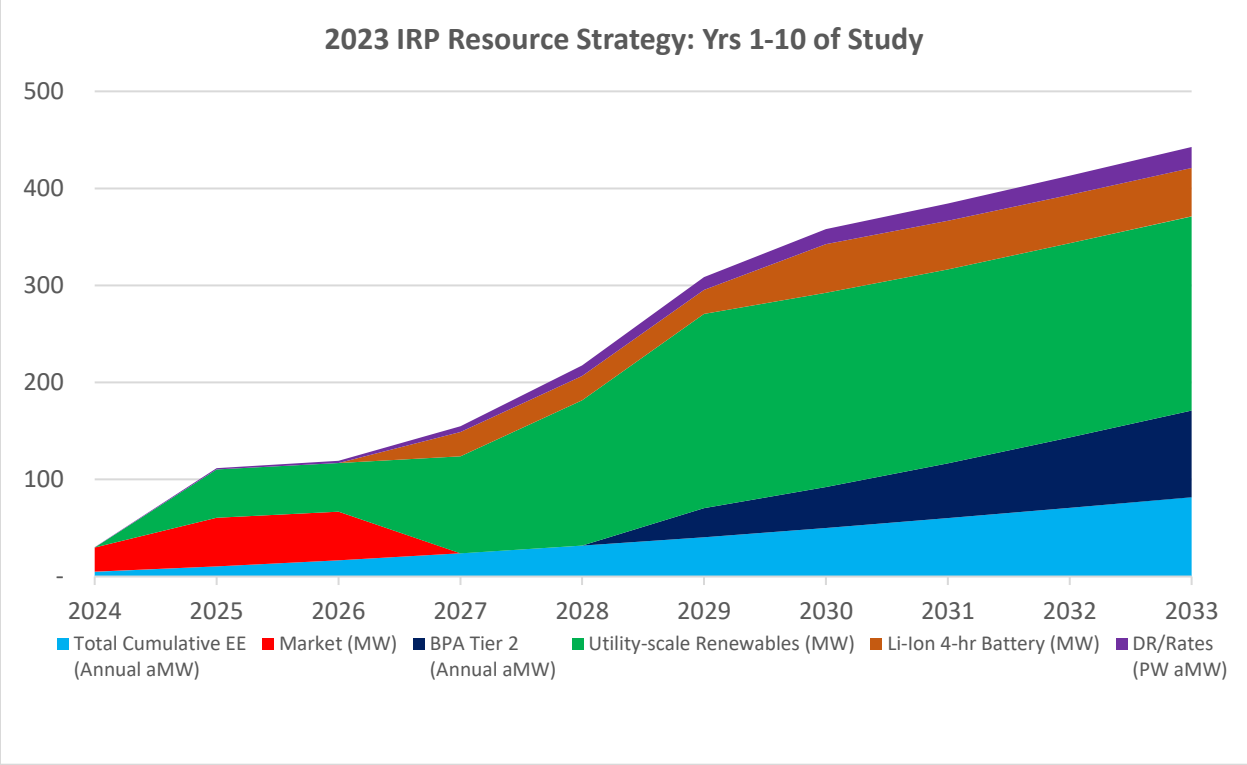
The building blocks of the Resource Strategy are discussed above, and are provided in graphical, quantitative form below. The Resource Strategy represents the lowest-cost solution to the Base Case scenario which is discussed in more detail in Sections 6 & 7.

Years 1-10 of the Study Period

Years 1-10 of the study period represent calendar years 2024-2033. In this period the PUD has 217 MW of expiring wind contracts and expects a new BPA Power contract starting in 2029. The resource strategy assumes continuation of the BPA Block/Slice Power product, and a PUD election to receive BPA Tier 2 Power. The PUD will continue to make conservation investments throughout the study period and will procure short-term market contracts until sufficient supply-side resources can be procured.

Through this period, the 217 MW of expiring wind contracts are replaced by 200 MW of new renewable resources, comprised of a mix of wind and solar. In addition to underway procurement of a 25 MW battery, the PUD would procure 50 MW of additional local energy storage. The PUD also expects optional customer programs for Demand Response and Smart Rates could yield approximately 20 aMW of peak period energy shifting. These investments are depicted in Figure 1-1.

Figure 1-1: Resource Strategy for Years 1-10 of Study Period

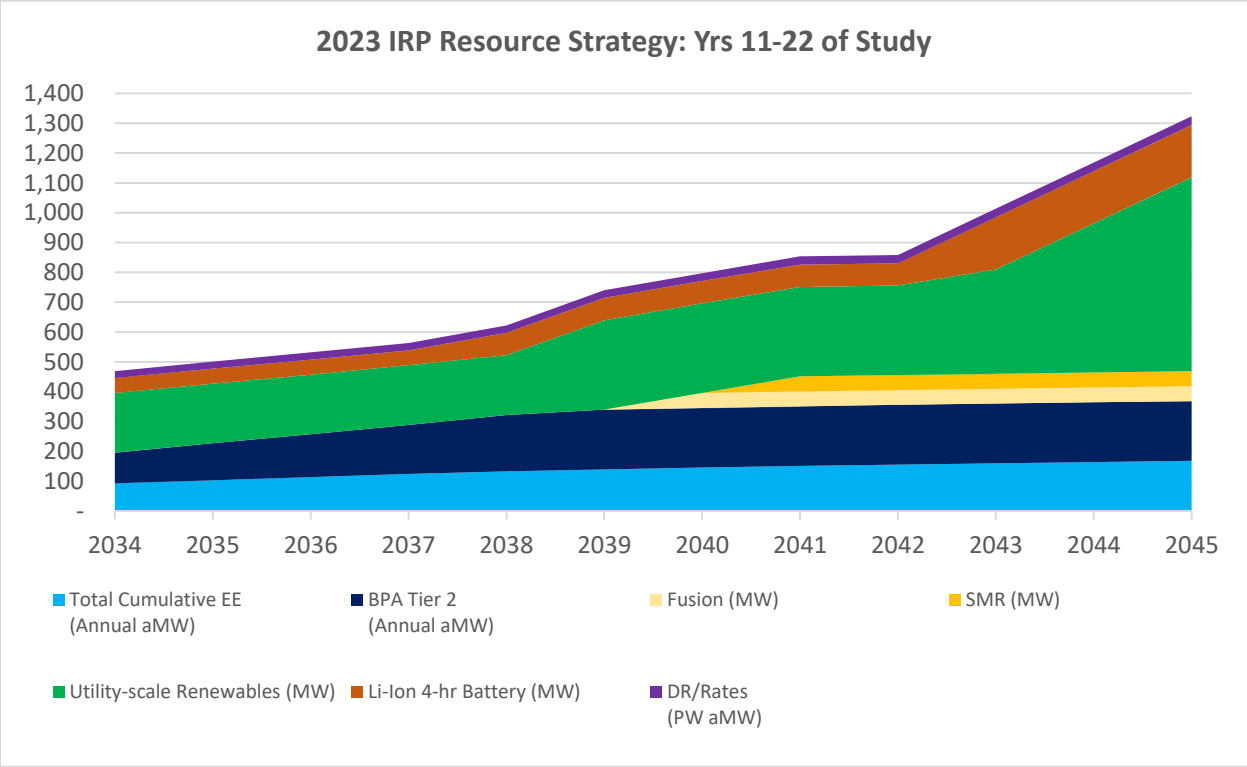


Years 11-22 of the Study Period

Years 11-22 of the study period are the most uncertain. Long-term load forecasts assume trends in electric vehicles, building electrification, and local economic growth. On the supply-side, technology improvements are providing more options at lower costs. However those options are also paired with uncertainty regarding transmission constraints, and the specifics of the technological advances. Understanding these risks and uncertainties, the 2023 Update has identified a flexible approach to serving future load growth.

The strategy calls for additional renewable energy, local energy storage, conservation investment, and Demand Response and Smart Rate options. The PUD plans to procure 200 aMW of BPA Tier 2 Power, which is less than its forecasted 388 aMW of eligibility. The PUD is also tracking regional and local efforts on clean energy technology from fusion and Small Modular Reactor (SMR) technology, including these resources in the 2023 Update's analysis if they are available at a cost-effective price in the 2040's. If they are not available at a cost-effective price, the PUD can either invest in additional renewable resources or acquire additional increments of BPA Tier 2 Power. Figure 1-2 depicts Years 11-22 of the Study period.

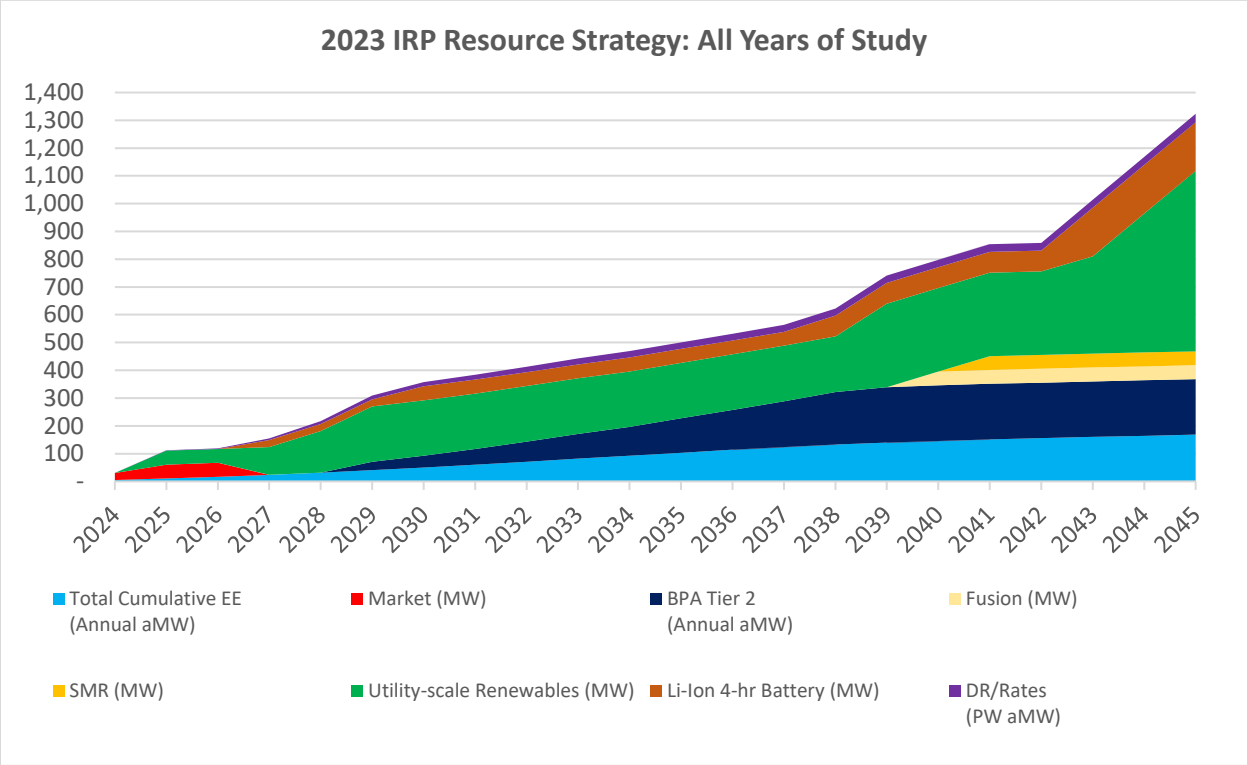
Figure 1-2: Years 11-22 of the Study Period



All Years of Resource Strategy

The complete Resource Strategy is reflected in Figure 1-3. This Resource Strategy is subject to change and will be revisited in the next comprehensive IRP. Because the PUD adopts IRPs every two years, the specific strategy can adapt and evolve as the PUD moves into the future.

Figure 1-3. All Years of Study Period



D. Action Plan

Action Plan items identify the actions and activities the PUD expects to take in the time period between adoption of the 2023 Update and adoption of the 2025 Comprehensive IRP. When implementing a flexible Resource Strategy during a period of complex electric industry change, the PUD must balance concrete proactive actions with actions that will enable prudent future decision-making. As a result, the action plan includes: (1) specific actions the PUD will take, (2) Due Diligence activities that must be started in order to enable future possibilities, and (3) analytical enhancements that will enable continuous improvement for resource acquisition decision-making. Through adoption of the 2023 Update, the Commission will direct PUD staff to undertake these actions. Progress made toward completing this Action Plan will be described in the 2025 Comprehensive IRP.

- **Actively engage with BPA's post-2028 contract process and analyze new power products**
    - The PUD's BPA Power contract accounts for roughly 85% of the PUD's current portfolio. Our current BPA contract expires in 2028, and the PUD expects to be able to sign a new contract in the fall of 2025. Negotiating the new BPA contract and fully evaluating all BPA Power Product offerings is essential to understanding future resource needs.

- **Acquire 10.54aMW or more cost-effective conservation by 2025**
    - The 2023 Update sets a biennial conservation target of 10.54 cumulative annual aMW for 2024-2025. Conservation remains a critical resource for meeting future load growth as it has in previous IRP cycles. The acquisition of conservation savings reduces the demand for electricity, delaying the need to acquire or develop more expensive and/or less effective new resources reducing the overall cost of energy and capacity. This has the effect of deferring additional transmission and distribution capacity upgrades. If the PUD can cost-effectively acquire more than 10.54 aMW of conservation, it would accelerate portfolio benefits and the PUD should identify the resources needed to accomplish such a gain.

- **Continue planned development of additional Time of Day Rate options for customers, and explore additional cost-effective demand response programs**
    - The PUD will leverage Advanced Meters to provide additional rate options for customers. Time-of-Use and Critical-Peak-Pricing programs were successful in shifting customer demand from high-cost periods to lower-cost periods in PUD pilot programs. The PUD will continue plans to offer these programs at scale to customers.
    - The PUD will also explore programmatic demand response programs that appear to have potential for cost-effectiveness. These programs include customer-owned battery programs, and commercial and industrial space heating incentive programs.

- **Develop low-cost, locally sited energy storage, and perform due diligence for future projects**
    - The 2021 IRP targeted 25 MW of energy storage for 2024, and PUD staff are currently pursuing procurement that would add 25 MW in 2025. Staff will continue current efforts to acquire this resource for that time frame.
    - The 2023 Update identifies additional energy storage as helping meet portfolio flexibility needs. PUD staff will undertake due diligence on the siting, development structure, and technology type for future energy storage investments to be ready to act once BPA contract and product parameters are known – likely 2024. This due diligence will include leveraging Energy Storage Department staff, collaboration with PUD system planning

and substation engineering staff, and evaluation of multiple sites for potential development. Site analysis will include analysis of potential long-duration storage opportunities at the Jackson Hydrogeneration campus with the Generation Department.

- **Perform due diligence on regional renewable energy projects, and prepare for potential procurement activity**
    - 200 MW of new renewables are identified in Years 1-10 of the Resource Strategy, dependent on the BPA Power contract and product. This volume of new renewables would replace aging, retiring renewables with newer and more efficient technology. Renewable resources take time to develop and in order to be prepared for potential renewable additions, staff will start due diligence activities now, making flexible procurement plans. Due diligence activities include but aren't limited to: evaluating the potential to access existing projects, monitoring regional RFPs and announced contracts for best practices and price points, evaluating transmission needs, talking with regional peers to identify partnership opportunities, and contacting regional developers to understand what projects are furthest in the development pipeline.

- **Acquire 50MW of short-term market contracts**
    - The 2023 Update identifies a need for a total of 50 MW market-sourced energy and capacity which serve to augment the portfolio until physical renewable resources can be developed or acquired. PUD staff will perform due diligence on the best fit market products, including consideration of specified clean energy contracts that may be available and contribute to Renewable Portfolio Standard goals.

- **Ensure continued compliance with state clean energy mandates**
    - The PUD is committed to meeting or exceeding clean energy and carbon regulatory requirements. The PUD forecast the need to acquire Renewable Energy Credits (RECs) in the near-term for meeting Renewable Portfolio Standards due to growing loads, retiring wind contracts, and a pause in new renewable development and acquisition. PUD staff will continue to establish plans for this budgeted expense. The PUD continues to only consider adding clean energy resources to its long-term portfolio.

- **Continue commitment to best-practice rooftop solar customer processes, while continuing evaluation of Community Solar project opportunities**
    - Customer feedback has consistently indicated a desire for more customer rooftop solar in partnership with the PUD. The Resource Plan evaluated additional incentives for customer rooftop solar based on feedback from the initial Clean Energy Open House but found that additional incentives would have the effect of raising overall costs for customers. While PUD staff will continue to evaluate incentive opportunities, until such time as new incentives are found to be cost-effective for all customers, PUD staff will focus on continuing to offer best-practice processes for customer rooftop solar interconnection.
    - The PUD has been successful in developing cost-effective and inclusive Community Solar projects. PUD staff will continue to explore project opportunities with the potential to develop local low-cost renewables in partnership with customers, including through Community Solar offerings.

- **Perform due diligence on local hydro capacity uprate projects**
    - A hydro capacity uprate project considers adding a small variable height weir at run of river hydro projects which provide run of river hydroelectric projects limited energy shaping capability. This project enhancement could potentially add low-cost capacity to existing PUD projects. PUD staff will perform due diligence on the technical feasibility, costs, and prudence of capacity uprate projects at PUD operated sites.

- **Develop and enhance local partnerships for fusion energy**
    - Snohomish County is home to a developing fusion energy sector and the PUD is well positioned to develop relationships with local fusion energy developers. The PUD will support local fusion companies and continue to follow advances in this sector.

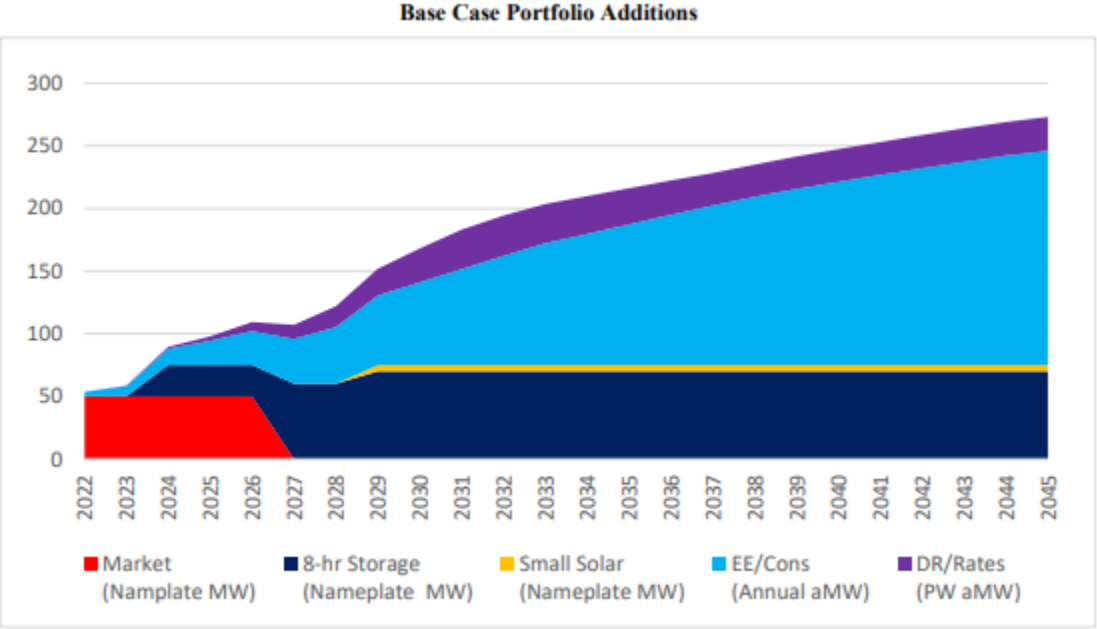
- **Continue participation in regional forums on climate change modeling, resource adequacy development, and organized market formation**
    - The PUD will continue to participate in regional forums and assess impacts associated with climate change, reduction in greenhouse gas emissions, clean energy policy compliance, and regional power and transmission planning efforts. Staff will continue to participate in the development of a regional resource adequacy program to further limit reliability risks to customers. The PUD will continue to participate in regional forums discussing the formation of organized markets in the Pacific Northwest with a focus on ensuring hydropower is appropriately valued, that the economic opportunities and risks of planned dispatchable resources are accounted for, and to appropriately forecast future cost of service.

2. Overview

A. Background and Approach

Snohomish PUD's 2021 Integrated Resource Plan ("IRP") was adopted by the Board of Commissioners in December 2021 and covered the 2022 through 2045 study period. It was filed with the Washington State Department of Commerce in December 2021, and forms the foundation for the 2023 Update to the 2021 IRP analysis. The 2021 IRP's Long Term Resource Strategy is shown in Figure 2-1 below.

Figure 2-1: 2021 IRP Long-Term Resource Strategy



The same modeling tools for load forecasting, and resource forecasting from the 2021 IRP were used in the 2023 IRP Update, but many of the variables changed. As further described in this study, load forecasts have increased, supply-side costs have decreased, Post-2028 BPA Power contract assumptions have been updated and market price forecasts have increased. These factors all update the 2021 IRP Resource Strategy to generally require more resources to serve future load.

The 2023 Update is based on the same principles and analytical framework as the 2021 IRP:
1. Meet load growth first by pursuing all cost-effective conservation;

2. Understand the probabilistic range of available energy and capability from the PUD's existing and committed resources and range of impacts on the load resource balance across the 20-year study period;

3. For future load growth not met by the PUD's existing and committed resources and new conservation acquisitions, pursue clean, renewable resource technologies taking into consideration resource options that provide the optimum balance of environmental and economic elements;

4. Comply with all applicable state laws and regulations, Board policies, and established District planning standards; and

5. Preserve the PUD's flexibility to adapt to changing conditions.

At the beginning of 2023, the District's IRP Technical Advisory team defined the scope for the 2023 Update analysis by reviewing the planning environment and key planning assumptions. The team also incorporated several after action review and process improvement items from the 2021 IRP analysis.

The 2023 IRP Update studies the 2024 through 2045 period across three different futures: the "expected" or Base Case, the Low Growth Case, and the High Growth Case. The analyses performed also test sensitivities to the Base Case if the PUD were to purchase different Bonneville Power Administration (BPA) power products.

B. Regulatory Requirements

Integrated Resource Planning – RCW 19.280

As a utility with more than 25,000 customers and that does not rely upon BPA for all of its energy needs, the PUD is required under Washington law to create a comprehensive IRP every four years. The PUD must also update those IRPs after two years to document progress on the plan and reflect changing conditions.

The 2023 Update is consistent with the PUD's state regulatory requirements, reflecting a progress report to the 2021 IRP analysis with least cost/least risk portfolios to meet future load growth across three different futures. The evaluated portfolios considered a mix of demand and supply-side resources, including renewable and nonrenewable resources. The 2023 Update also incorporates the results of a new Conservation Potential Assessment (CPA) using an integrated portfolio approach for three different futures, using a societal cost of carbon. The Long-Term Resource Strategy identified a 10-year conservation potential estimate of 92.8 aMW for the 2024 through 2034 study period.

Energy Independence Act (EIA) – RCW 19.285

The 2023 IRP Update considers the requirements of the EIA and incorporates them into each of its scenarios. While further detail can be found in Section 7, the 2023 IRP Update finds that the PUD will meet its Washington state annual Energy Independence Act (EIA) renewables requirement through 2030 utilizing a combination of renewable energy credits (RECs) from existing PUD renewable resources, incremental hydro, and RECs allocated through the BPA long-term power contract and acquired from the market. Given the PUD's forecast surplus annual energy position under average water conditions, procuring some portion of compliance RECs from third parties in the 2020 - 2029 period was identified to be the most cost-effective way to meet the EIA's RPS requirements at this time.

Post-2030, the EIA compliance pathway provided under the Clean Energy Transformation Act for 100% clean utilities provides significant incentive for the PUD to reach 100% clean ahead of the 2045 requirement date; all scenarios indicate this is a high plausibility occurrence.

Clean Energy Transformation Act (CETA) – RCW 19.405

CETA requires utilities to have at least 80% clean energy by 2030 and 100% by 2045. Because the PUD is expected to clean attributes surplus to its load in most scenarios from 2022 to 2045, and because the

PUD has committed not to acquire any emitting resources for its portfolio, it is anticipated that the PUD will be able to satisfy all CETA standards. Further discussion of how the PUD performed this analysis is provided in Section 5.

Climate Commitment Act (CCA) – RCW 70A.65

The Climate Commitment Act, also called the Cap and Invest program, establishes a cap on carbon emissions economy wide in Washington state with specific provisions for electric utilities. Because the program is primarily measured on an operational basis, there is no specific requirement to include a planning component in the IRP. However, the CCA represents an important regulation upon electric markets and affects prevailing market prices. These effects will be monitored and incorporated into the next comprehensive IRP.

C. Progress on 2021 IRP Action Plan

The 2021 IRP Action Plan has seen significant progress since its adoption as follows:

1. **Pursue all cost-effective conservation**

The PUD is pursuing all cost-effective conservation to meet the 2021 IRP targets. The 2022-2023 Biennium target is 7.90aMW and in 2022 the PUD acquired 5.54aMW and is on pace to acquire 4.5aMW in 2023 for an expected total of roughly 10aMW.

2. **Pursue acquisition of significant long-duration utility-scale energy storage**

After performing a feasibility study for energy storage options, the PUD began procurement of a locally sited 25MW, 100MWh battery. At the time of publication, it is expected that this procurement activity is likely to result in a commercial operation date of 2025 for this resource, though that process is not complete.

3. **Develop a roadmap to significant, lowest-cost Demand Response programs**

Automated Metering Infrastructure (AMI) rollout enables the PUD to implement low-cost Time-of-Day and demand response programs. The PUD has developed specific plans to offer Time-of-Day rate options for customers in alignment with AMI rollout. Those plans were discussed with the Commission during an August 22, 2023 Commission Briefing, and are modeled in the 2023 IRP based on their forecast ability to shift load for participating customers.

4. **Further develop geospatial modeling capabilities of demand-side resource potential**

The PUD has developed geospatial indices for the location of conservation and demand response potential across its Distribution System as part of the Conservation Potential Assessment and Demand Response Potential Assessment processes, and identified the leveraging and development of this data as an item in its organizational Strategic Plan.

5. **Continue to enhance and leverage short and long-term resource portfolio modeling capabilities**

The PUD has significantly improved the modeling of energy storage resources both as standalone projects and when directly paired with renewable generation. Resource models in the 2023 Update incorporate firming in order to dispatch renewable resources into peak week hours. Additionally, staff built a portfolio optimization model built to optimize resources around the BPA Load-Following Product for use in 2023 Update, as well as the rate and product design portions of the BPA contract negotiation.

6. **Continue to participate in regional forums and assess impacts associated with climate change**

District staff continue to engage with regional forums and incorporate climate change into the IRP load forecasts and resource characteristics. The PUD works with the Bonneville Power Administration to determine any seasonal effects of climate change regarding hydrology and hydropower. Additionally, clean energy mandates imposed by state law underscore our customers' desire to be served by carbon-free energy. This is reflected in the PUD's 2021 Clean Energy Implementation Plan (CEIP).[1] The PUD will continue to iterate upon the existing CEIP both internally and with regional partners as part of the PUD's commitment to clean energy.

7. **Continue to participate in the development of a regional resource adequacy program**

The PUD has completed a Western Resource Adequacy Program Agreement (WRAPA) and selected a binding season to coincide with other regional peers. This binding season represents the date that the PUD will be subject to the WRAP and be required to meet resource adequacy standards. WRAP is still under active development and the PUD is advocating for targeted improvements to the program while checking resource plans against potential future WRAP requirements.

8. **Continue to participate in regional forums discussing the formation of organized markets**

The PUD has continued to engage with the regional market development efforts and committed to funding Phase One development of Southwest Power Pool's Markets+ initiative. The PUD also joined the California Independent System Operator (CAISO) Energy Imbalance Market through BPA's market entrance and is actively working on CAISO's Enhanced Day Ahead Market (EDAM).

9. **Continue to participate in the Post-2028 contract negotiation process with the Bonneville Power Administration**

PUD staff are heavily involved with BPA's Post-2028 contract discussions providing technical leadership and regional advocacy. The PUD has been involved in the Post-2028 process primarily through direct advocacy, and also partners with regional entities that share common goals and principles such as the Public Power Council, and other Slice and planned product customers. This action item is ongoing and represents a key component in the PUD's future portfolio.

[1] 2021 Clean Energy Implementation Plan. https://www.snopud.com/wp-content/uploads/2022/12/2022-2025_CEIP_Draft_122122_AppUpdate.pdf

3. Changes Reflected in 2023 IRP Update

The 2023 Update reflects fundamental planning assumption variables that have changed since the PUD's 2021 Integrated Resource Plan. In particular, the two most significant variable changes are an increased load forecast due to electrification and the Federal Inflation Reduction Act's (IRA) cost reduction effects on certain supply-side resources.

A. Revised Load Forecast

Across each of the three scenarios studied in this IRP, revised load forecasts predict a relative increase in net load by sector when compared to the 2021 IRP. This net increase does not manifest until approximately 2030 at which time significant new electrification occurs, such as electrifying buildings and new electric vehicle load. Anticipated new electrification is the biggest single driver of increasing net load. Figure 3-1 below shows load growth for the base case scenario relative to the corresponding 2021 IRP's base case. Each line represents net system load after forecast energy efficiency and rooftop solar, with red representing the 2023 Update and the black representing the 2021 IRP.

Figure 3-1: Annual average load forecast changes and load segments

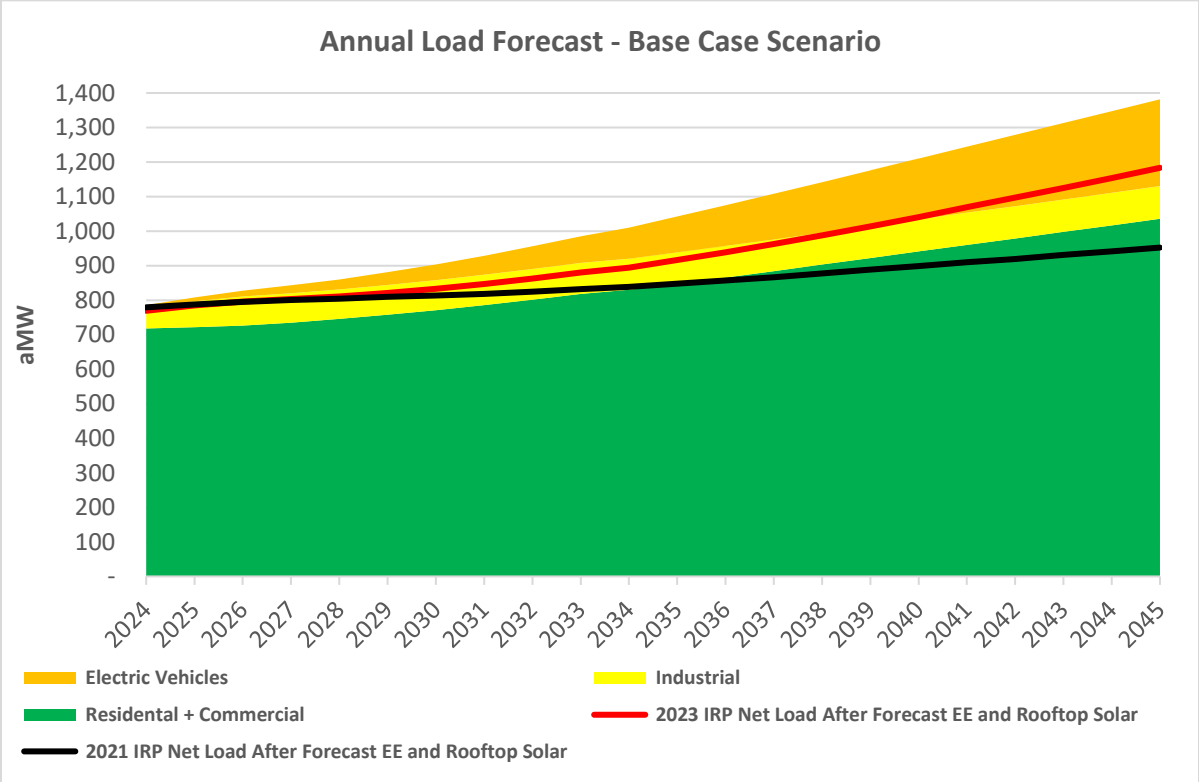
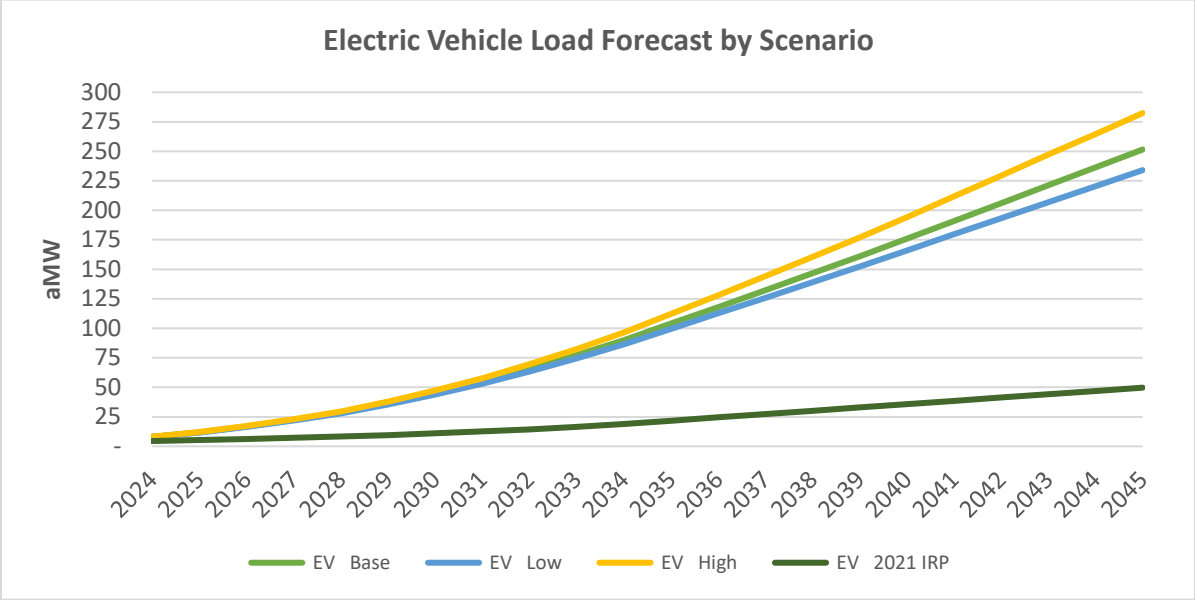


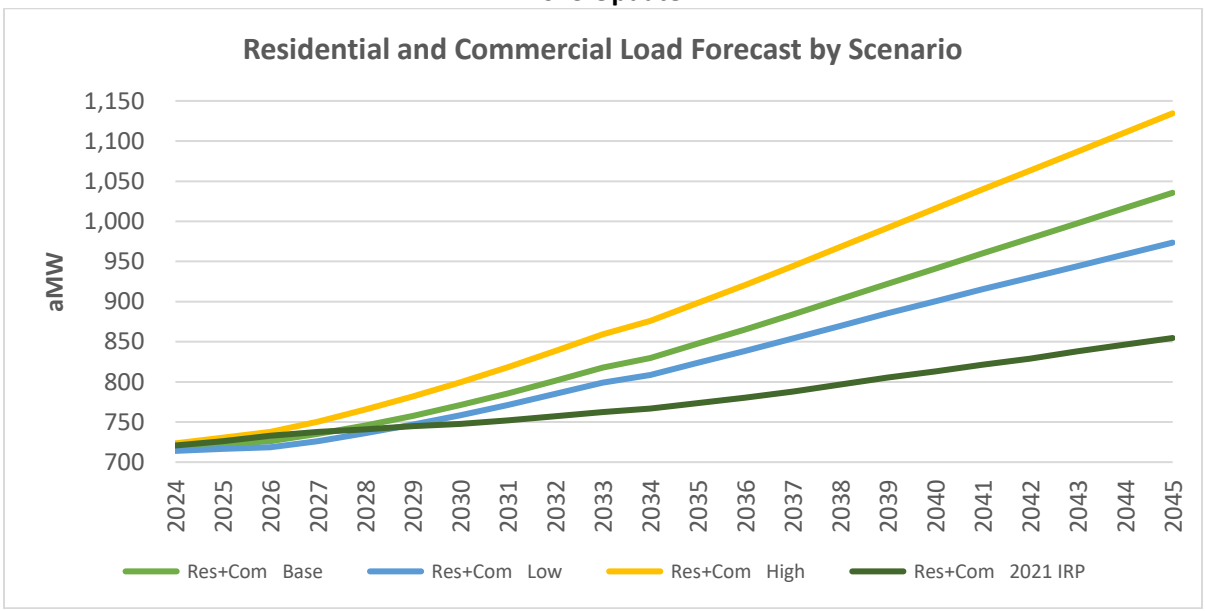
Figure 3-2 below shows the electric vehicle load forecast difference between the 2021 IRP and the 2023 Update before new conservation is considered. The 2023 Update includes significantly more forecast electric vehicle load regardless off the scenario (Low, Base, or High).

Figure 3-2: Changes in electric vehicle load assumptions between 2021 IRP and 2023 Update



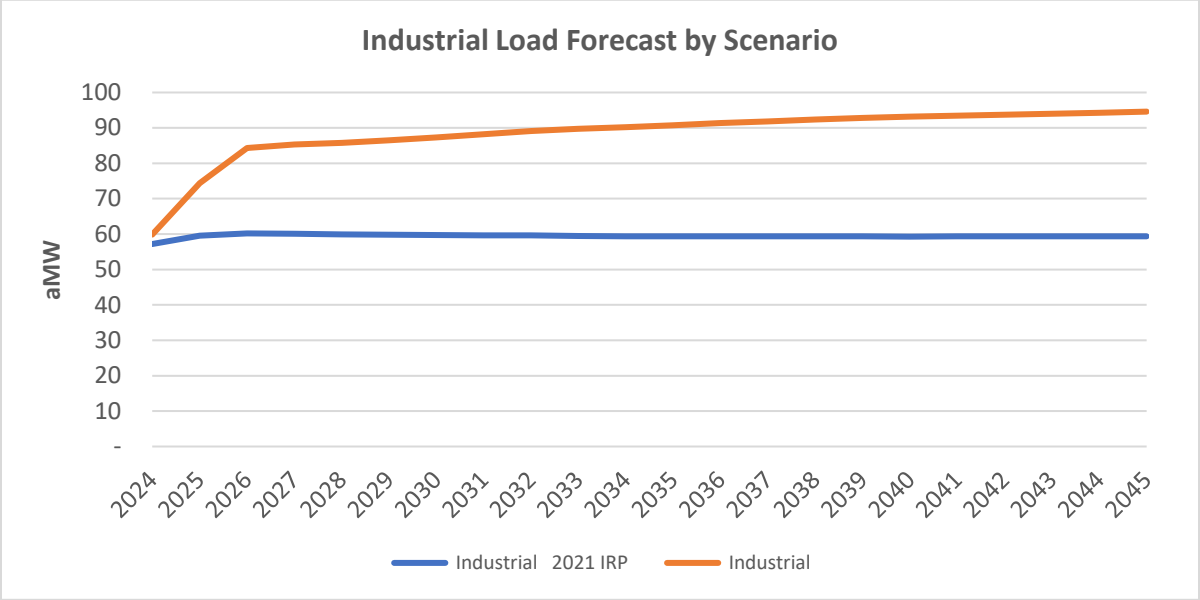
Residential and commercial load forecasts are increasing largely due to building electrification and population growth. In the Base Case scenario, this change in forecasts largely occurs after 2028. Figure 3-3 below shows this growth before new conservation is considered.

Figure 3-3: Changes in residential and commercial load growth assumptions between 2021 IRP and 2023 Update



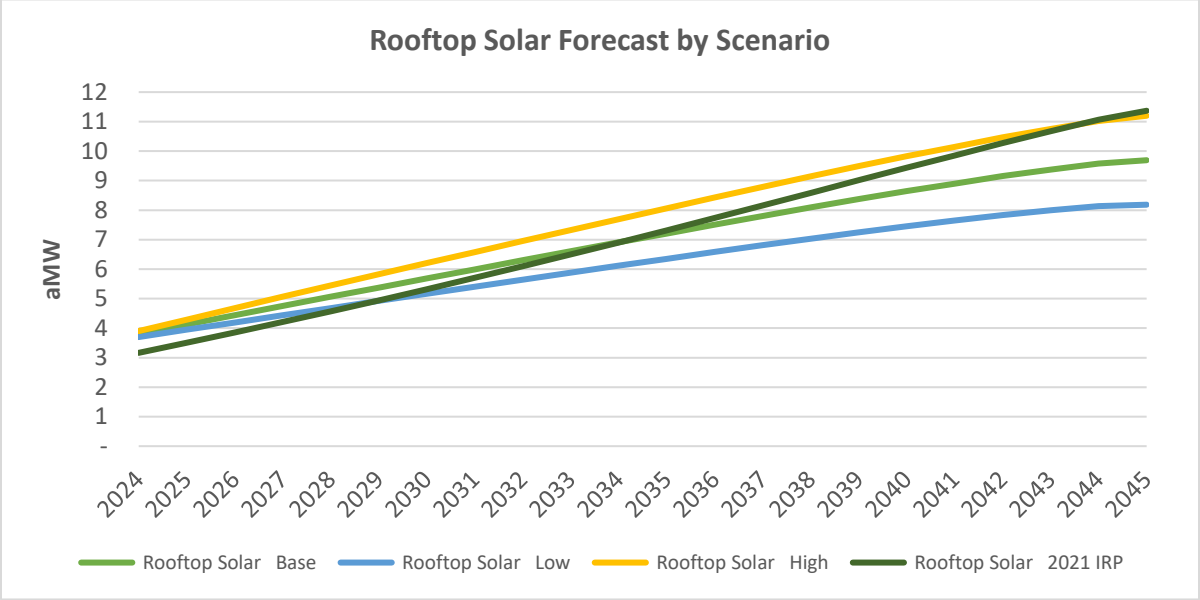
The increasing industrial load forecast is driven primarily by a new planned recycling center, with other planned expansions of local industry over the first two to three years. The industrial load forecast is identical in each of the low, base, and high growth scenarios. Figure 3-4 below displays this industrial growth before new conservation.

Figure 3-4: Changes in industrial load growth assumptions between 2021 IRP and 2023 Update



The rooftop solar forecast has been adjusted slightly as reflected in figure 3-5 below. The forecast change reflects a higher than forecast installed nameplate as a starting point, with a lower level of forecast growth over time than the 2021 IRP. Rooftop solar has the effect of reducing the load needed to be served by the PUD.

Figure 3-5: Changes in rooftop solar growth assumptions between 2021 IRP and 2023 Update



Peak net load is a significant driver of resource acquisition. The PUD must be able to cost-effectively meet load during periods of high demand. These periods typically happen during extreme weather events and/or poor hydrological conditions. If the PUD does not have enough portfolio resources to meet these severe events, energy acquired in the wholesale energy market exposes the PUD to significant market price risk. Figures 3-6 and 3-7 below respectively show the expected (or P50) and

1-in-20 (or P95) net peak load growth forecasts by month throughout the full IRP study period. In general, Peak loads for all months are expected to grow, peak loads in the winter (January, February, November, and December) are expected to remain the PUD's peak load months, and spring months are expected to remain lower peak load months. Of course, actual weather will dictate actual peak load months within a year. All forecasts explicitly account for climate change impacts on temperature distribution changes across the study period.

Figure 3-6: P50 Net Peak Load by Month 2024-2045

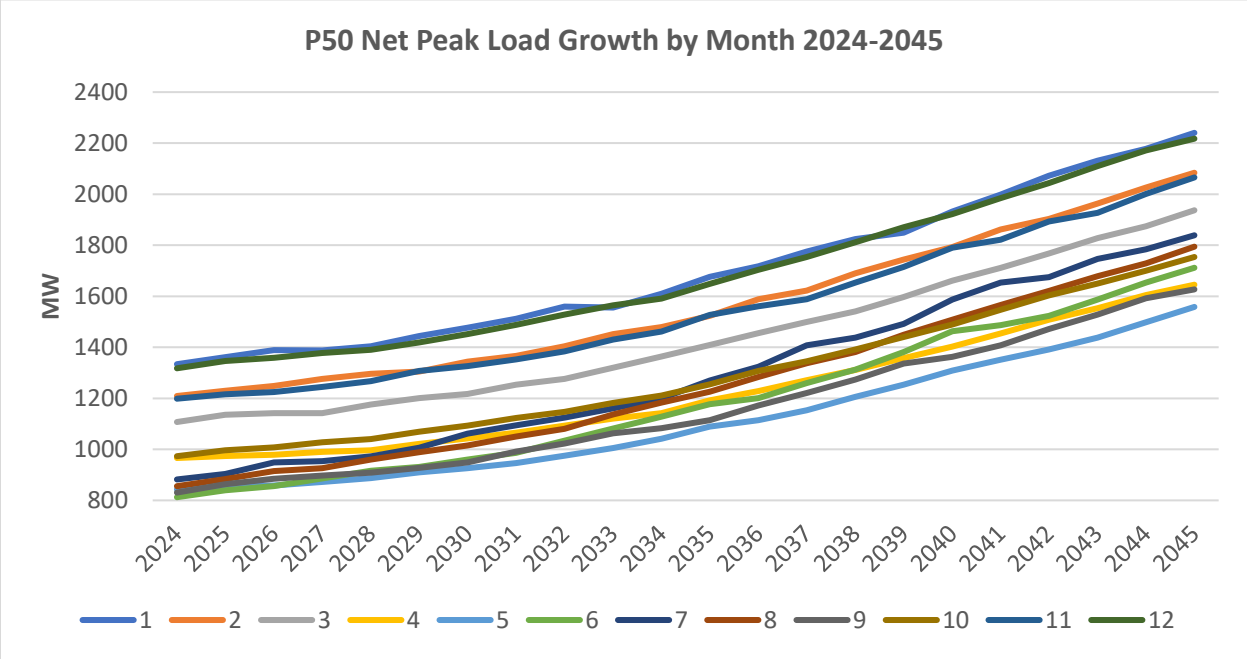
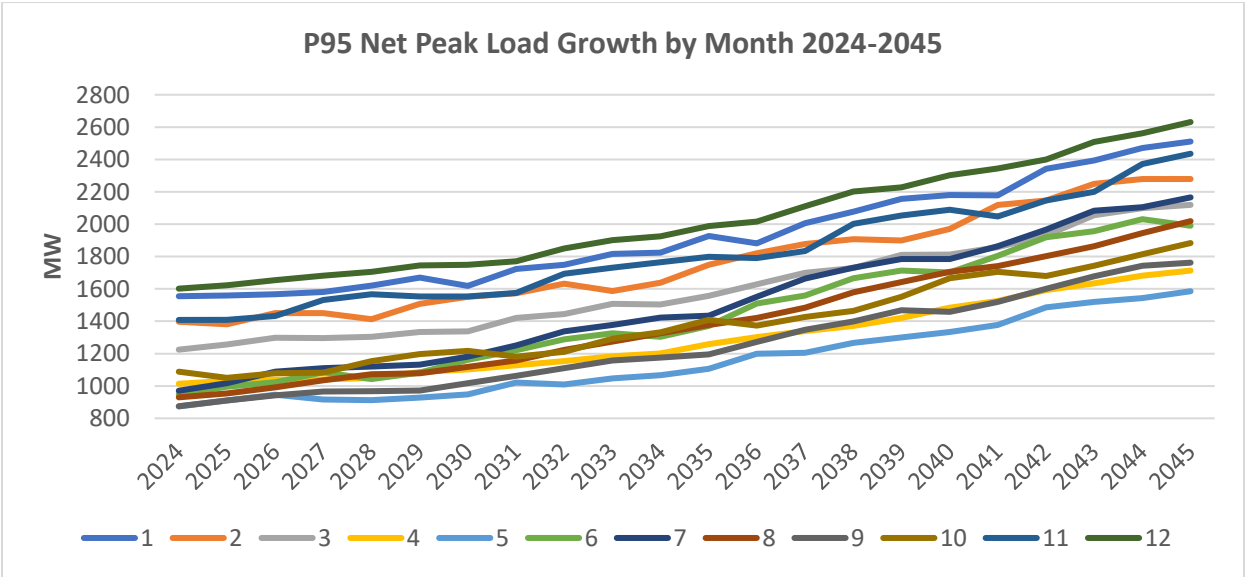


Figure 3-7: P95 Net Peak Load Growth by Month 2024-2045



B. Revised Capital Cost of Supply-side Resources

As new technologies are discovered and existing technologies shift over time, the costs of supply-side resources typically change from one IRP cycle to another. The 2023 Update captures these technological and commercial maturations, generally pushing down capital costs of resources such as renewables and batteries. National Renewable Energy Laboratory's annual All Technology Bulletin report informs the PUD's perspective on the impacts of technological change on cost [2] . In addition, this update also considers the new federal tax credits as passed in the Inflation Reduction Act of 2022 (IRA).

The IRA provides a tax credit relative to the capital cost of a new resource if that resource meets certain established criteria. Generally, new renewable and new energy storage resource developments are eligible for the tax credit if construction starts within a given timeframe. The credits diminish for resources starting construction in 2034 and disappear entirely by 2036. The amount of the tax credit is also highly variable based attributes of the project itself, such as the physical location of the resource, domestic material contents, and finance structuring. For the 2023 Update, the PUD assumed a base tax credit of 30 percent for all eligible new resources built before 2034, and then adjusted accordingly based on how the PUD may plan to finance a new utility-scale resource development, and the impact of project development timing on tax credits.

C. Revised Market Price Forecast and Approach

The pacific northwest has seen increasing volatility in its wholesale energy market over time, particularly during adverse regional weather events such as cold snaps, heat waves, and dry seasons. To reflect this increasing risk, this IRP update has adopted a new approach for determining the optimal portfolio buildout and resource strategy.

In previous IRPs, a portfolio was only tested against its assigned market environment. For example, the base case scenario would only be tested against the base case market environment. However, in this IRP update the base case portfolio buildout is tested against all market environments to measure how that portfolio performs under varying market conditions. Figure 3-8 below shows the whole market energy price[3] forecast by scenario at the Mid-Columbia trading hub. Price forecasts range from declining, flat, to increasing.

[2] 2022 NREL ATB Report: https://atb.nrel.gov/electricity/2022/index

[3] As in the 2021 IRP, the 2023 Update builds into each market energy price forecast the social cost of carbon as defined by the Clean Energy Transformation Act. Social Cost of Carbon (wa.gov)

Figure 3-8: Annual Average (or "Flat") Market Price Forecast by Scenario

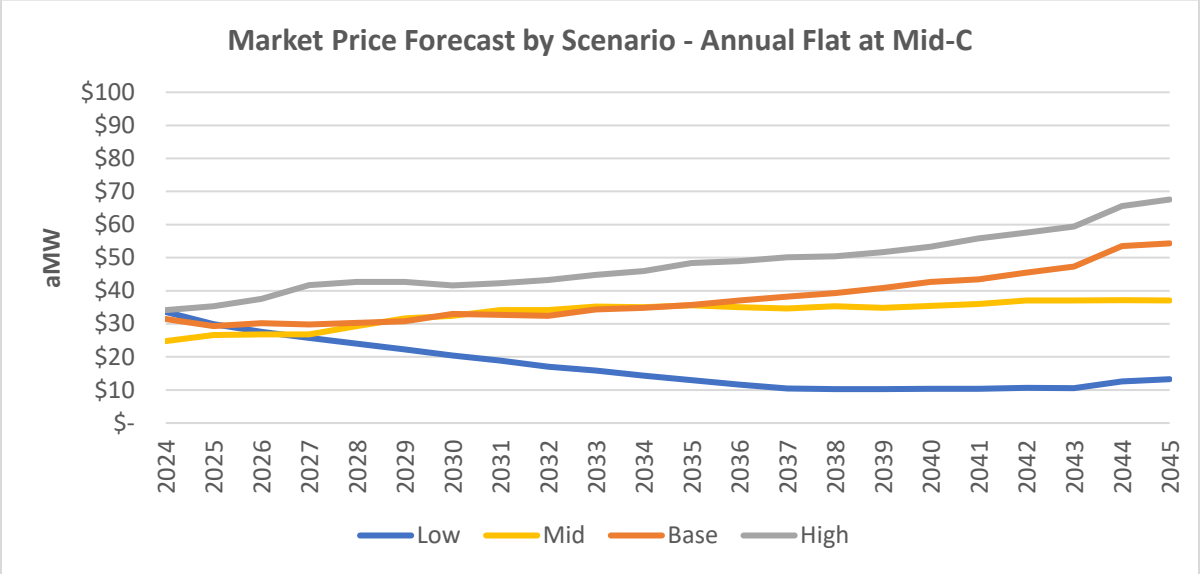


Figure 3-9 below shows the winter seasonal on-peak (HLH) wholesale energy price forecast by scenario. Prices range from declining to increasing, and most winter on-peak energy prices are higher than annual average market prices.

Figure 3-9: Winter On-Peak Energy Prices by Scenario

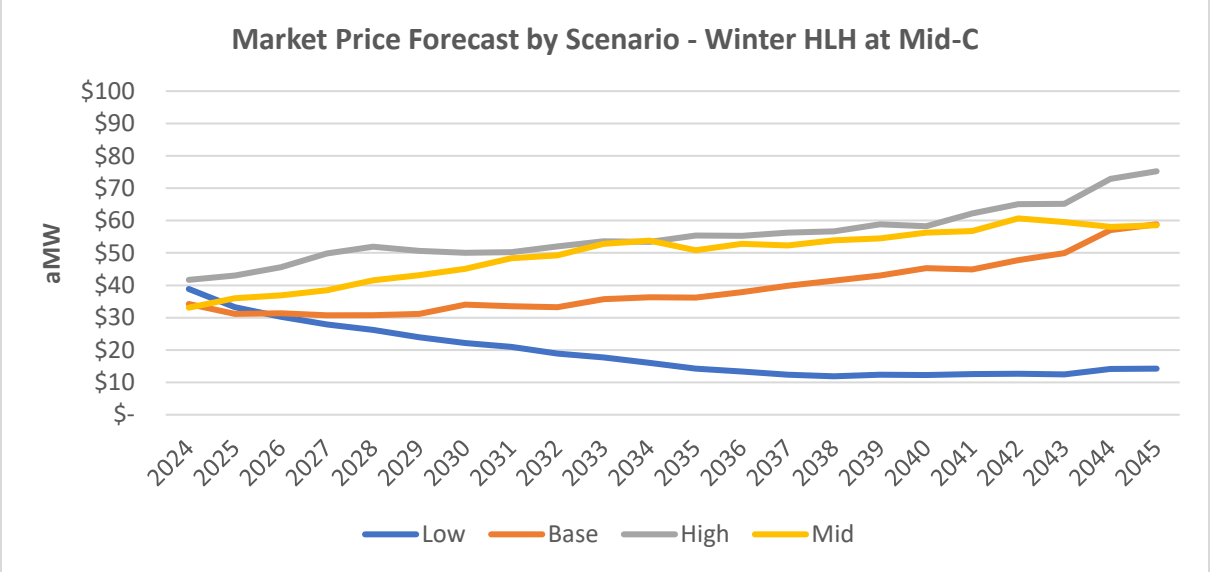
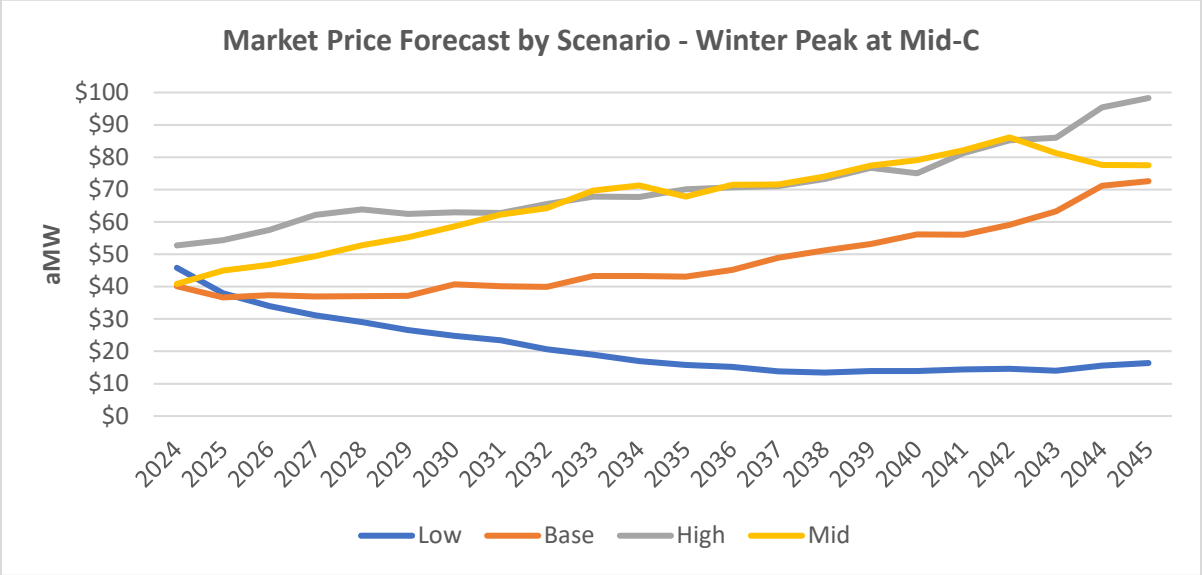


Figure 3-10 below shows the winter seasonal peak week wholesale energy price forecast by scenario. Winter peak prices represent energy prices during the 8 hours during the day with highest regional loads. While price forecasts vary, in general they are significantly higher than average winter seasonal on-peak prices and annual energy prices.

Figure 3-10: Winter Peak Energy Market Price Forecast



D. BPA Assumptions

The PUD's BPA power contract is a significant portion of the PUD's power supply, representing approximately 85% of its overall portfolio. As such, the upcoming long-term BPA contract will continue to play a major role in how the PUD serves its customers cost-effectively. That contract will start at the expiration of the current contract (2028), and is expected to stretch until 2045. At the time of this update, there is still uncertainty regarding the exact specifications and allocation of BPA Tier 1 power.

The 2023 Update assumes an allocation of 755 aMW of BPA Tier 1 power based upon the most recent information available from the Post-2028 BPA contract process. While this number could still change it is worth noting this is slightly less (1.3%) than assumed in the 2021 IRP at 765 aMW. While each scenario assumed the PUD would continue to purchase the Block and Slice product, analysis was also performed to determine whether BPA's Load Following product could be a better fit for the next BPA contract period. The results of this analysis are found in section 6 of this 2023 Update.

BPA Tier 2 power is also a significant consideration. BPA offers Tier 2 energy when customers need to serve load that is in excess of their Tier 1 allocation. Tier 1 power is energy provided at cost to customers from the low-cost federal system, and it has an average current cost of around $35 per MWh. Tier 2 power can be sourced from either the wholesale market (deemed "Short-Term Tier 2") or from new physical resources (deemed "Long-Term Tier 2"), and is priced at either the wholesale market or the cost to develop new resources. Today, both forms of Tier 2 would be significantly more expensive than Tier 1. The PUD has not needed to purchase a Tier 2 product under its Regional Dialogue contract. However, due to significantly increased load forecasts, the PUD may exceed its Tier 1 allocation within the first year of the new contract, and it is expected that some level of Tier 2 service could help serve load and diversify load service sources.

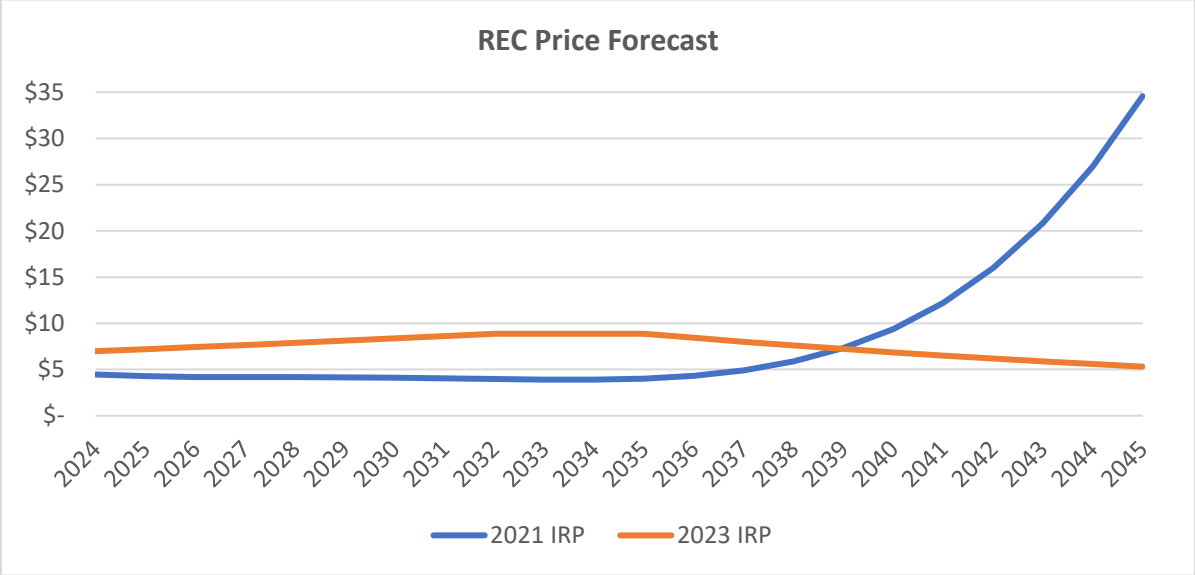
For planning purposes and risk mitigation, the 2023 Update assumes the PUD would be most interested in Long-Term Tier 2 sourced from clean energy sources, and puts a 200 aMW cap on the amount of long-term Tier 2 available in the optimization. Long-term Tier 2 provides price stability

due to its basis on long-term assets, and should also help the PUD with clean energy and carbon regulatory compliance. The PUD expects it would have access to additional Short-Term Tier 2 after if it has exceeded its elected cap of Long-Term Tier 2. The PUD seeks to line up this optionality for potential lower wholesale electricity prices in the future in the event regional renewable resource build out for clean energy policies pushes down wholesale prices as forecast. All Tier 2 product features are subject to change through the Post-2028 BPA contract negotiation period, and specific assumptions will be re-evaluated once final details are available.

E. Other Planning Assumption Updates

The Renewable Energy Credit (REC) price forecast has been updated. Staff analysis found that the 2021 IRP's REC price forecast overvalued RECs during the final years of the study period. Figure 3-11 below shows the revised price forecast.

Figure 3-11: REC Price Forecast



4. Resource Need

The planning standards and analytical framework used in the 2023 Update have not changed from the 2021 IRP. The load forecast is an econometric stochastic model developed internally to provide a range of load forecasts for each scenario. Further, climate change and weather volatility are factored into customer load forecasts and hydrogeneration capability probabilistically to create a load-resource balance forecast.

The framework requires all portfolio buildouts to meet the following planning standard metrics:

1) Fiftieth Percentile Annual Energy – The portfolio must meet average annual energy demand across all years at expected or median conditions.

2) Fifth Percentile Monthly On-Peak Heavy Load Hours (HLH) – The portfolio must meet monthly on-peak demand 19 out of 20 times. This standard allows up to a 100 aMW deficit under P5 conditions.

3) Fifth Percentile Monthly Peak Week (PW) – The portfolio must meet monthly PW demand 19 out of 20 times. This standard allows up to a 150 aMW deficit under P5 conditions.

4) Regulatory Compliance – The portfolio must comply with all regulatory requirements such as, but not limited to, the Energy Independence Act, Clean Energy Transformation Act, and newly added sections of the Electric Utility Resource Plan statute[4].

As with the 2021 IRP, the two most constraining metrics are the P5 Monthly HLH and the P5 Monthly PW standards. Effectively, solving for these two metrics solves for all binding metrics. Figure 4-1 below shows the P5 Monthly HLH net position for each scenario assuming only planned conservation from the 2021 IRP. Exceedances in the planning standard occur when any scenario represented falls below -100 aMW on the vertical axis. Generally, exceeding the P5 Monthly HLH standard was solved by adding new energy generation resources and new additional energy efficiency.

[4] Sections added by 2022-2023 Legislature Senate Bill 5165 regarding Transmission Planning.

Figure 4-1: P5 Monthly HLH Net Position Forecast before New Resources by Scenario

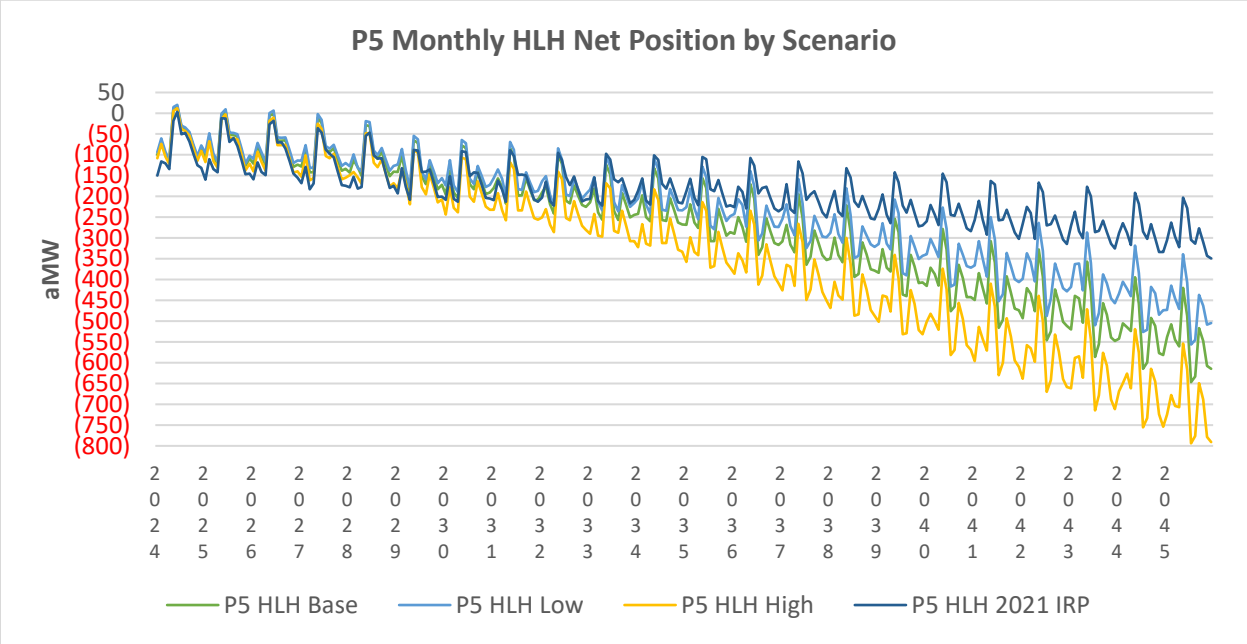
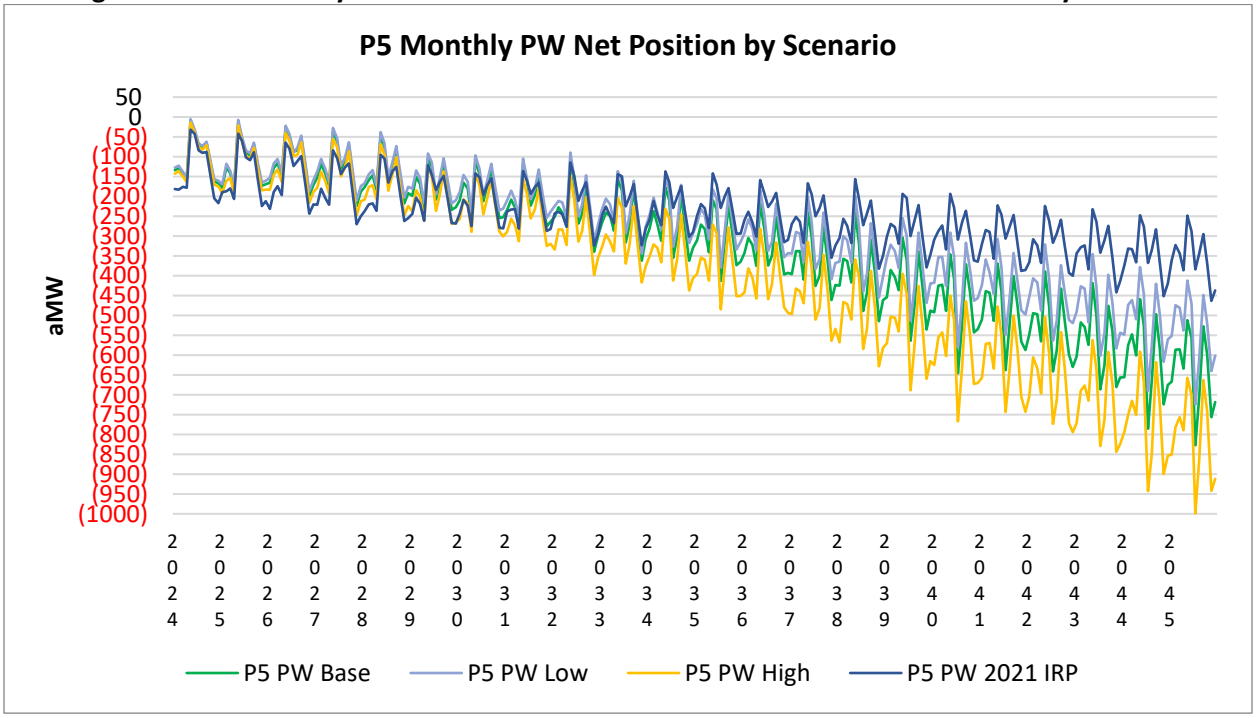


Figure 4-2 below shows the P5 Monthly PW standard net position for each scenario after planned conservation from the 2021 IRP. Exceedances in this planning standard occur when any scenario represented falls below -150 aMW on the vertical axis. Generally, exceeding this planning standard was solved by adding new capacity resources such as energy storage and demand response.

Figure 4-2: P5 Monthly Peak Week Net Position Forecast before New Resources by Scenario



Finally, the 2023 IRP Update considers a non-binding metric based off of the Western Resource Adequacy Program's (WRAP) qualified capacity credit (QCC) framework and cost. The WRAP program is still in development and many metrics produced by the program are dependent upon the number of regional participants and how the program integrates with organized markets efforts in the western United States. WRAP needs are also closely correlated with measured Peak Week needs. For the 2023 Update, the planning framework does not introduce a new WRAP planning standard for portfolios, but does measure any forecast additional needs independently and in parallel with portfolio solutions on an advisory basis. This advisory treatment in the 2023 Update allows an evaluation of how portfolio buildouts for any scenario work with potential WRAP obligations, and if any additional needs would be present based on currently available information. It is anticipated that the internal IRP framework will incorporate a long-term binding WRAP metric into the planning standards in the comprehensive 2025 IRP.

5. Resource Options

The IRP's analytical approach to identifying resource needs also considers scale, timing, and probability. The PUD uses an integrated portfolio approach to finding the most cost-effective portfolio additions. The integrated portfolio approach evaluates demand-side resources, supply-side resources, and market resources (including the market for environmental attributes) in a single economic optimization, allowing the PUD to observe multiple dimensions of potential resource value.

For conservation, this approach helps to quantify its peak capacity contributions relative to other resources, while simultaneously valuing its regulatory compliance value of reducing load. Supply side and demand side resources are evaluated using the same measurements: their potential contributions to capacity, energy, and satisfying regulatory requirements. In this way, portfolios assembled the best mix of demand and supply side resources to meet that scenario's future need, based on least-cost criterion.

A. Demand-Side Resources

The PUD contracted Lighthouse Energy Consulting for a 2023 Conservation Potential Assessment (CPA) and 2023 Demand Response Potential Assessment (DRPA). These reports identified the available demand side resources.

i. Conservation

The CPA identified all achievable potential conservation within the PUD's service territory over the 22-year study period. The CPA used measures' savings, costs, and other characteristics based on the measures included in the Northwest Power and Conservation Council's (NWPCC) 2021 Power Plan, with updates from the Regional Technical Forum (RTF) and additional customizations to make the measures specific to the PUD.

The 2023 IRP incorporates the results of the CPA into its integrated portfolio approach to identify the portion of achievable potential that is considered cost-effective within each scenario. The methodology employed in the 2023 IRP Update is the same as the 2021 IRP.

The CPA assessed each achievable technical conservation measure and sorted the measures into two seasonal bins with eight different sub-bins organized by levelized cost. The two seasonal bins are annual measures and winter measures, where annual measures reduce load an annual basis, and winter

measures which reduce load only in the winter months of November through February. This organization methodology produces a total of 16 "bundles" of conservation measures from which the 2023 IRP economic optimization model could select, alongside supply-side resource options, that most cost-effectively meets that portfolio's needs. For a comprehensive list of studied measures see the 2023 Conservation Potential Assessment.

Figure 5-1 displays the annual energy savings achievable from the "Annual Measure" bundles, by price point. The majority of the available savings are inexpensive, under $45 per MWh. There are smaller volumes available of more expensive measures, those expected to cost greater than $85 per MWh.

Figure 5-1: Annual Energy Savings from "Annual Measure" Cost Bundles

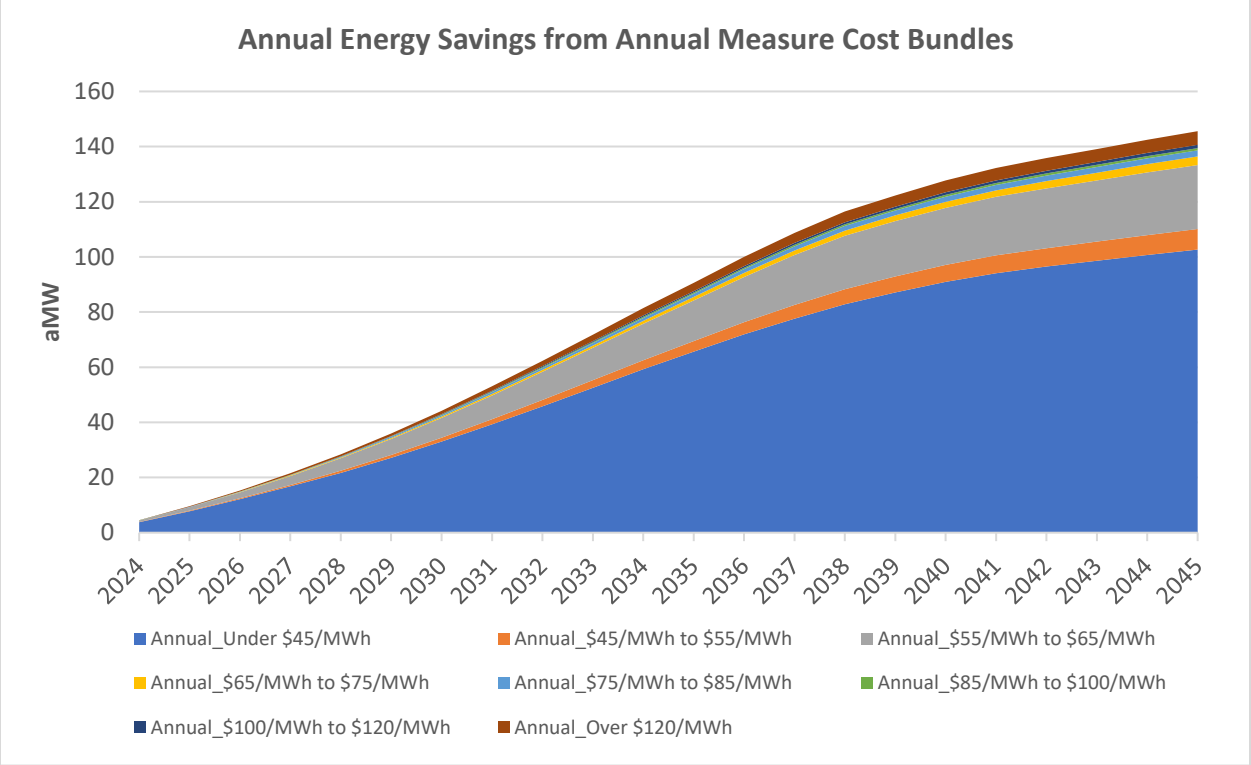
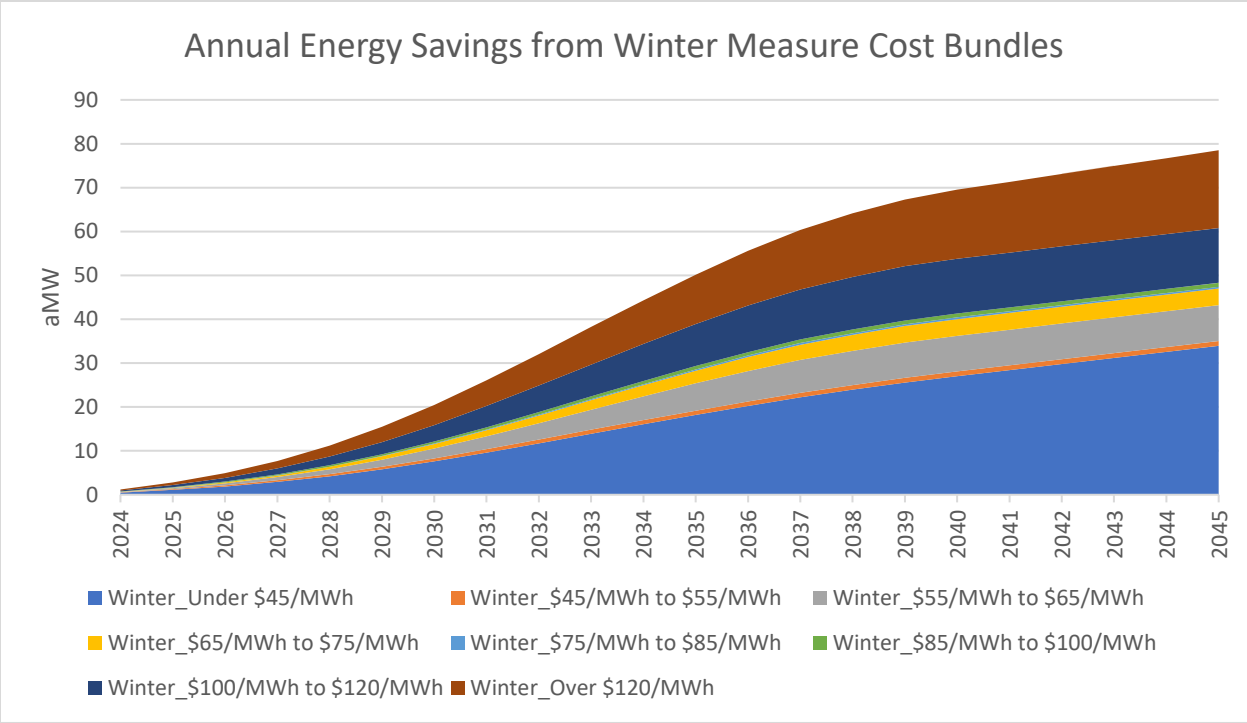


Figure 5-2 displays the annual energy savings achievable from "Winter Measure" bundles, by price. The potential is more evenly spread across price points, with low-cost measures (under $45/MWh) representing about half of overall potential.

Figure 5-2: Annual Energy Savings from "Winter Measure" Cost Bundles



ii. Peak Demand Management

Peak demand management through customer load shifting represents a new opportunity for the PUD to manage energy. The Northwest Power and Conservation Council's 2021 Power Plan defines demand response as "a non-persistent intentional change in net electricity usage by end-use customers from normal consumptive patterns in response to a request on behalf of, or by, a power and/or distribution/transmission system operator"[5]. Driving the need for cost effective capacity options are growing peak loads and increasing local and regional use of non-dispatchable renewable energy sources.

Peak demand management mitigates the system peak, helps integrate renewable energy resources, and alleviates transmission and distribution congestion. Examples of peak demand management include:

- Time-of-Day rate programs, which enable new rate designs for achieving peak reduction and load shifting through financial incentives and time-sensitive pricing changes.
- Demand response or direct load control enable the utility to have direct control over sending a reduction signal via a pricing event or equipment programming. Direct load control programs grant higher efficiency per installation and increased flexibility for the increased costs associated with 3rd party equipment installation.

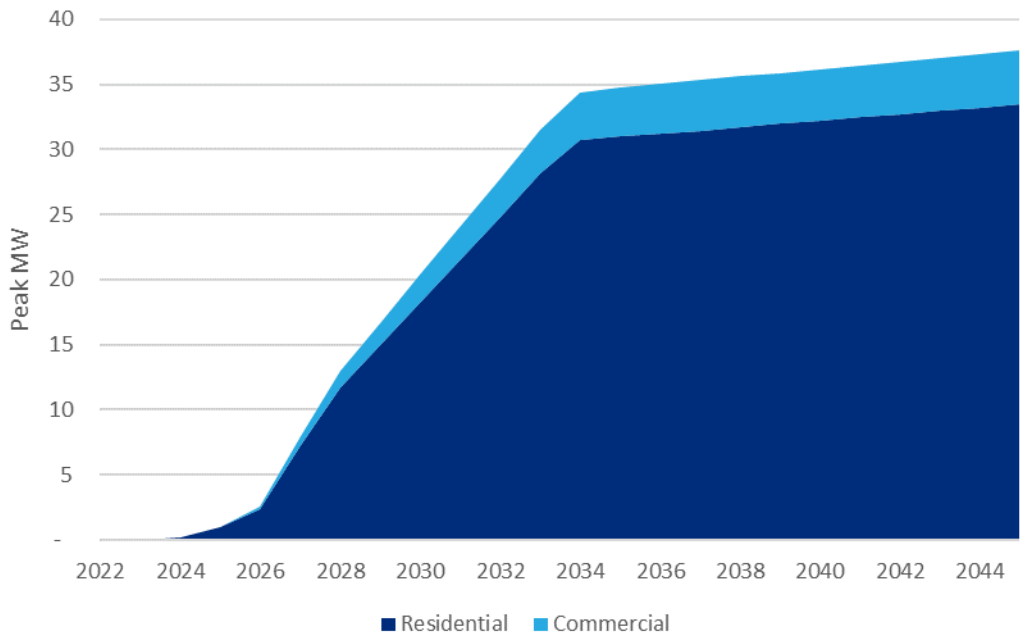
[5] 2021 Northwest Power Plan [The 2021 Northwest Power Plan (nwcouncil.org)]

a. Time-of-Day Rates

In 2022 the PUD commissioned Lighthouse Energy to develop a Demand Response Implementation Plan in response to the PUD's 2021 Clean Energy Implementation Plan demand response target for 5.6MW of peak hour reduction. The goal of the effort was to define a rate offering pathway that was achievable, provided more customer rate options, and was well aligned with the rollout of advanced meters which are required for Time-of-Day rates. The FlexEnergy pilot program for advanced rates demonstrated the efficacy of rate designs within Snohomish PUD customers to achieve the desired peak reduction. An achievable pathway was defined while acknowledging the challenges of supply chain delays, back-end system changes, customer support training, and deployment timelines that could effect timing and program performance. This effort progressed as the PUD piloted several rate offerings with customers and learned more about customer preferences, program performance, and internal PUD program management needed to support a high-quality customer experience. The 2023 Update incorporates the defined pathway established through that effort as a baseline expectation of load profiles.

The expected results of the defined pathway for time-of-day rate offerings, assuming conservative customer participation and in alignment with advanced meter rollout is about 35MW of peak load shifting by 2033, at which point programs will reach maturity and modest growth is expected largely through customer count growth and a proportion of new customers opting for Time-of-Day rates. Figure 5-3 illustrates peak load shifting potential anticipated from Time-of-Day rate program development.

Figure 5-3: Peak MW load shifting potential from Time-of-Day Rate program development



b. Demand Response

Demand response programs are identified in the 2023 Update in two ways: as direct load control through equipment-based measures such as a connected smart thermostat, or as demand curtailment in the form of call events for residential customers or industrial customers with back-up generation or energy storage to voluntarily temporarily switch to back-up sources at the direction of the PUD. These types of programs are generally more higher peak-shifting performance than advanced rate designs but come with higher costs associated with installing 3rd party equipment, back-end dispatch systems, and other transaction costs associated with establishing and maintaining program performance.

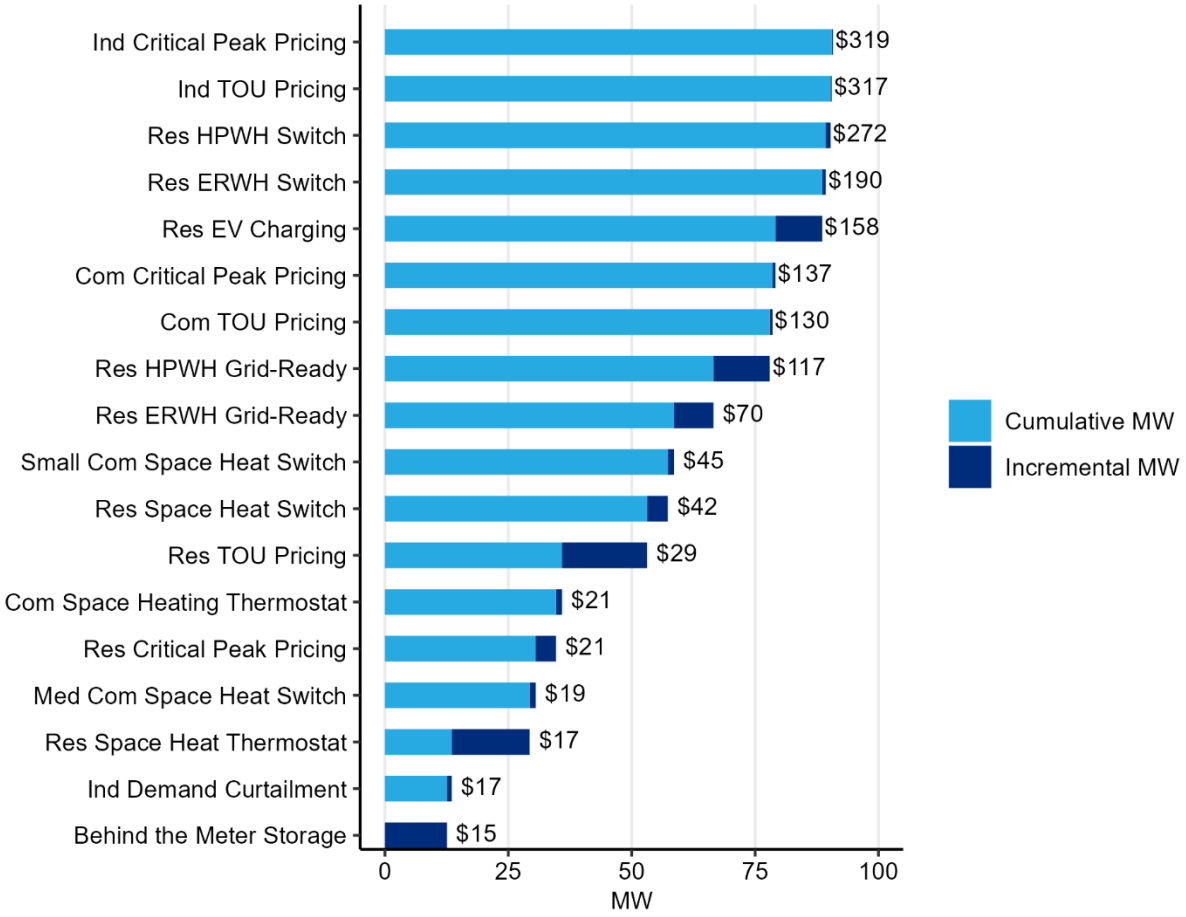
Figure 5-4 displays the types of Demand Management programs considered in the DRPA and 2023 Update. Time-varying rates are described as Time-of-Day Rates in the section above.

Figure 5-4: Demand Management Programs considered in the 2023 DRPA and 2023 Update

	Commercial	Industrial	Residential
Direct Load Control	Space Heating Switch Smart Thermostat		EV Charging Water Heater Controls Space Heating Switch Smart Thermostat
Demand Curtailment		Demand Curtailment	
Time-Varying Prices	Time of Use Rates Critical Peak Pricing	Time of Use Rates Critical Peak Pricing	Time of Use Rates Critical Peak Pricing

Figure 5-5 shows the incremental winter supply, cumulative winter supply, and costs of winter demand peak management of all demand-management programs. The maximum achievable demand reduction is 98MW at the end of the study period. The products are ranked by levelized cost ($/kW-year), with the lowest cost product at the bottom. Starting from the bottom of the chart and moving upward, the incremental Demand Response potential for each product is shown in dark blue, with the cumulative potential from all previous products shown in lighter blue. Residential Time-of-Use Pricing (a Time-of-Day Rate) has the greatest potential to shift load (largest dark blue bar) and comes at a relatively low cost ($29/kw-year). The horizontal axis reflects the Demand Response capacity and the value at the end of each bar is the levelized cost of each product. The levelized cost calculations include credits for deferred distribution and transmission system capacity costs. Industrial Critical Peak Pricing comes at the highest cost ($319/kW-year) and has a very low peak-shifting potential (smallest dark blue bar).

Figure 5-5: Winter DR Supply Curve (MW and $/kW-year)



B. Supply-Side Resources

The 2023 Update categorizes supply-side resources into three categories: baseload resource, variable energy resources, and capacity resources. Baseload resources have a stable generation profile that is similar through days and across months. An example baseload resource is a biomass generation facility. Variable energy resources have a generating profile that varies throughout the day and year and may have seasonal differences in energy production. Wind and solar generation are examples of variable energy resources. Capacity resources are dispatchable resources that can be controlled to dispatch into specific hours of the day and within certain months of the year in response to load conditions. Utility scale batteries are an example of a capacity resource. Resource options to considered in the 2023 Update, that were not considered in the 2021 IRP, are noted with an asterisk.

Baseload Resources

The 2023 Update evaluated baseload resources listed in Figure 5-6. Renewable energy with on-site storage acts to smooth the output of the otherwise variable resource, and both Wind+Storage and Solar+Storage were considered. The storage is assumed to be 50% of the renewable energy nameplate with energy storage capacity in MWh at 4 times the nameplate capacity of the storage nameplate. A 50MW Solar plus Storage reference plant includes 25MW of battery storage capacity and 100MWh of energy storage for example. Small modular reactors are modeled as first available in 2032 and the model assumes the PUD could be a contracted energy off-taker for a portion of a project but would not be a project owner. Additionally, the Update has added fusion energy as a resource option for the first time. Snohomish County is home to a growing fusion energy sector with multiple local companies contributing to technological advances. Fusion energy is given a deliberately cautious first year availability date and the prices are assumed to be at market rates. This treatment enables the PUD to consider whether fusion could be a good fit in the distant future, and enables the PUD to proactively develop long-term relationships with local partners in the event commercial projects can be developed with layers of community benefits.

Figure 5-6: Baseload Resources Considered

Name	Fuel Source	Nameplate MW	Units Available	First Year Available
Biofuel	Combusted Biomass	50	1	2025
Small Modular Reactor *	Nuclear Fission	50	1	2032
Fusion *	H2 Fusion	50	1	2040
E WA Solar + Storage	Solar	50	4	2025
Gorge Wind + Storage	Wind	50	4	2025
Montana Wind + Storage	Wind	50	4	2026
Firm Annual Energy Contract	Market Contract	25	2	2024

Variable Renewable Resources

The 2023 Update evaluated variable resources listed in Figure 5-7. The 2023 Update considered two run-of-river hydroelectric plant options: one new stream development and one buyout of an existing project. Both options were assumed to be located in Western Washington and modeled on existing PUD owned projects. Local solar is modeled as a 5MW solar plant located in Snohomish County. The rooftop solar incentive examines the costs and benefits of accelerating local customer rooftop solar installations via a one-time solar panel incentive. Solar and wind projects in this section do not have paired storage and are stand-alone energy projects.

Figure 5-7: Variable Renewable Resources Considered

Name	Fuel Source	Nameplate MW	Units Available	First Year Available
New Run of River Hydro	Run of River Hydro	7.5	1	2026
Run of River Hydro Buyout *	Run of River Hydro	7.5	1	2026
Local Solar	Solar Photovoltaic	5	1	2025
Eastern WA Solar	Solar Photovoltaic	50	5	2025
Gorge Wind	Wind	50	5	2025
Montana Wind	Wind	50	5	2026
Rooftop Solar Incentive *	Solar Photovoltaic	N/A	1	N/A

Clean Capacity Resources

The 2023 Update considered the capacity resources in Figure 5-8. Several configurations of local pumped hydro storage were considered with varying durations and output capability. Stand-alone lithium-ion batteries were modeled inside Snohomish County and were not paired with any specific renewable project. Regional pumped hydro storage was modeled as a shared project outside PUD territory with the PUD acquiring a share of the capacity along with other regional partners.

The PUD did not consider natural gas resources in the 2023 Update as a viable long-term capacity resource. This choice is reflective of the Commission's stated Climate Change policy, increasing regulatory uncertainty around fossil fuel resources, and analysis that concludes that the PUD could procure lower cost supply-side capacity resources through pursuit of storage resources. Natural gas plant pricing is provided as a price reference only for levelized energy and capacity price tables provided later in this section.

Figure 5-8: Clean Capacity Resources Considered

Name	Storage Duration	Nameplate MW	Units Available	First Year Available
Hydro Capacity Upgrade *		5	1	2029
Stand Alone Li-Ion Battery	4 Hr.	25	6	2026
Stand Alone Li-Ion Battery	4 Hr.	100	2	2026
300 MW Pumped Hydro	8 Hr.	300	1	2031
200 MW Pumped Hydro	10 Hr.	200	1	2031
200 MW Pumped Hydro	8 Hr.	200	1	2031
150 MW Pumped Hydro	10.66 Hr.	150	1	2031
Regional Pumped Hydro Share	12 Hr.	150	1	2026
Market Annual Capacity Contract	N/A	25	1	2024
Market Winter Capacity Contract	N/A	25	1	2024
Seasonal Capacity Exchange Contract	N/A	25	1	2024

i. Resource Cost

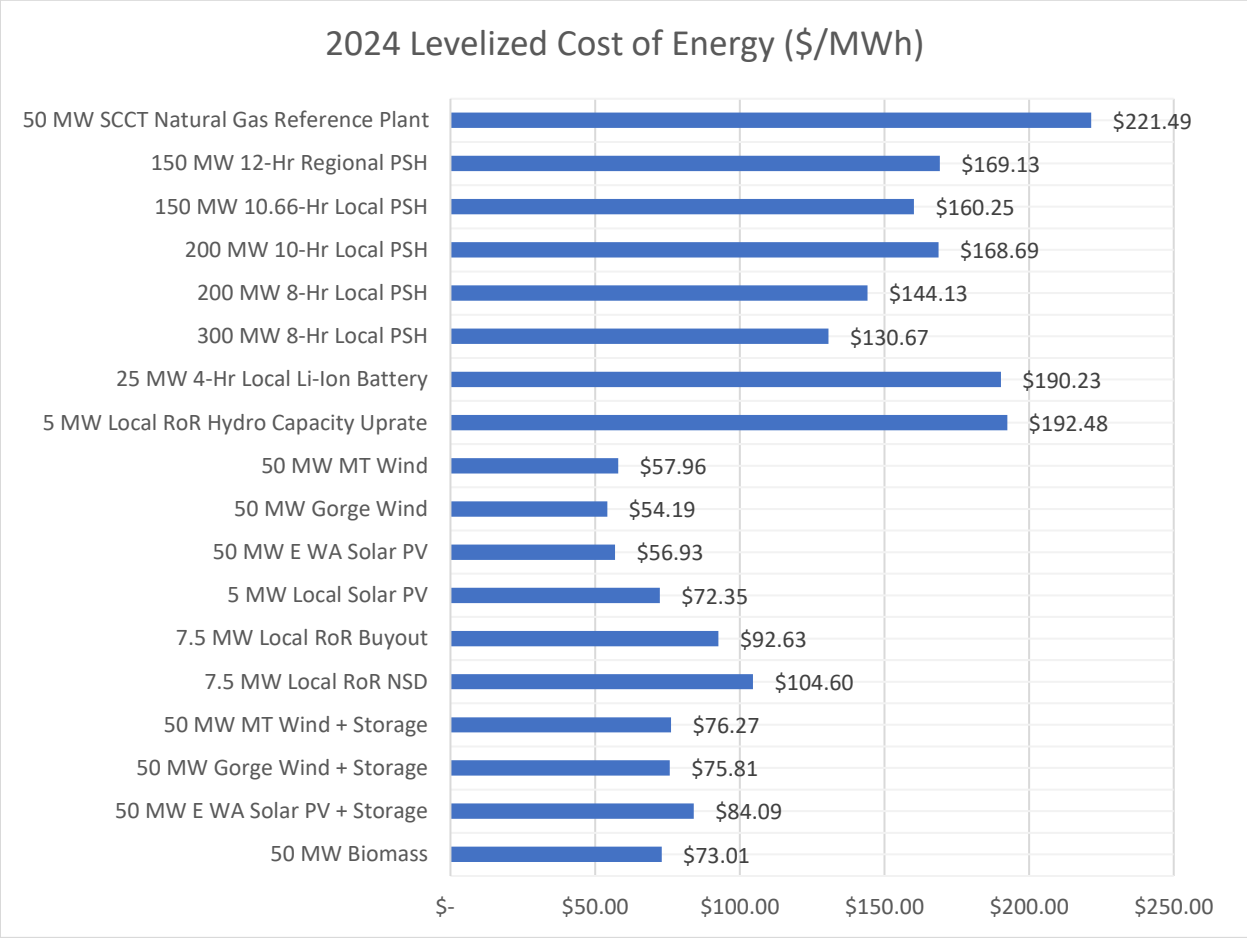
Supply-side resource costs in the 2023 Update represent the assessed total resource cost of developing and operating a resource. Operating costs include the cost of fuel (if applicable), the cost of transmission if the resource is sited outside the PUD's service territory, and the cost of ancillary services that may be required to support the resource such as Variable Energy Resource Balancing Service through BPA for wind energy. All costs assume a discount rate of 4.5%, are in US Dollars, and are converted to a 2022 dollar-year value. All federal tax credits such as the production tax credit and investment tax credit were included where applicable. Cost estimates were made in each feasible delivery year for each resource type, such that the economic optimization model could draw upon present value cost estimates while considering PUD ownership or offtake relationship of any given resource.

The PUD's methodology for determining supply-side resource costs is the same methodology used by the 2021 IRP. It is a composite of credible, third-party cost estimates for the Pacific Northwest region, and normalizing this value to the scale, dollar year, and cost methodology. Cost data was derived from other recent regional utility IRPs, the Northwest Renewable Energy Laboratory's (NREL) All-Technology Bulletins (ATB), and the Northwest Power and Conservation Council's 2021 Power Plan. For a more detailed description of the cost determination methodology see the 2021 IRP.

a. Levelized Cost of Energy

Levelized cost of energy represents a measure of the net present value of the energy production of a given resource over its lifetime. To fairly compare different types of resources, costs are normalized to 2024 even if the first available date is later in the study period. A comparison of the Levelized Cost of Energy across Supply-Side Resources is provided in Figure 5-9. Variable energy sources have the lowest levelized cost of energy due to low capital and operational costs. Baseload resources have higher levelized cost of energy than variable resources owing to their higher capital costs associated with paired storage or fuel costs in the case of biomass plants. Capacity resources have the highest levelized cost of energy as they are not high-volume energy producers but rather act as dispatchable resources that generate only when needed. Only resources with readily available pricing information are compared in this format.

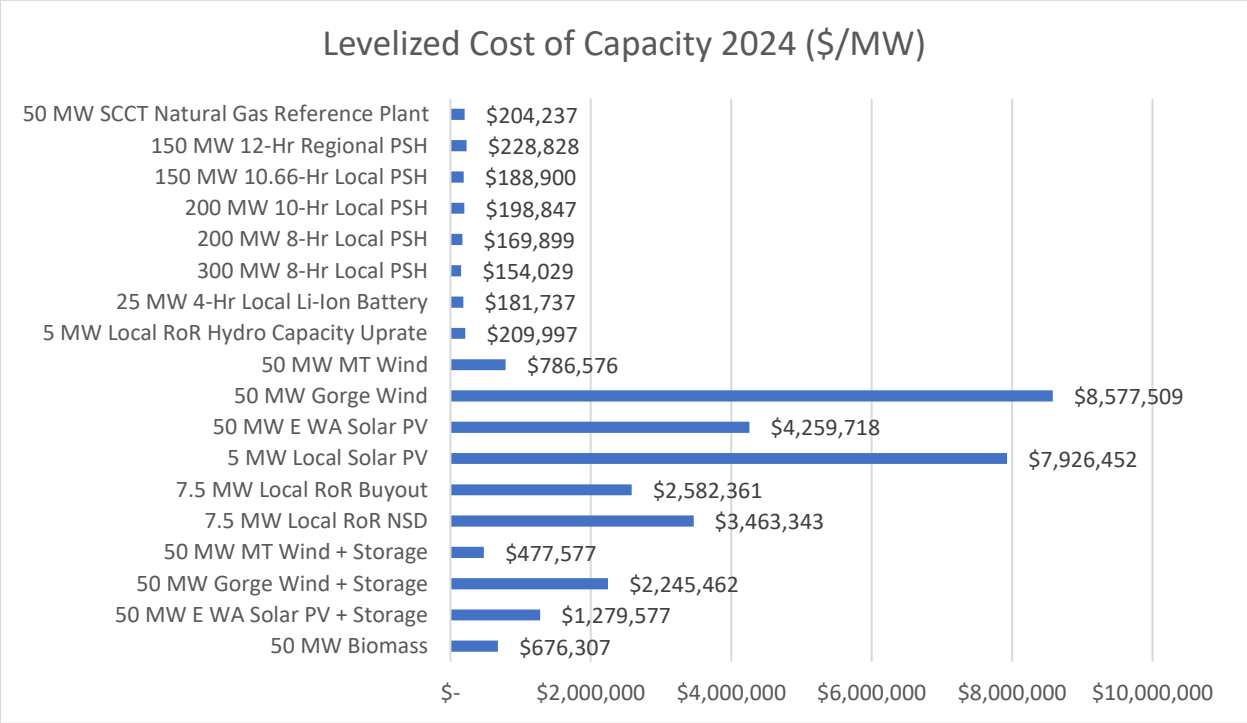
Figure 5-9: Comparison of Levelized Cost of Energy (LCOE) across supply-side resource options



b. Levelized Cost of Capacity

Levelized cost of capacity normalizes the total cost of a resource's ability to dispatch or provide energy in the winter peak week hours across all seasons in the project lifetime in the study period. This metric provides the cost of a resource to provide energy in the most needed hours across the project lifetime. A comparison of the Levelized Cost of Capacity (LCOC) across supply-side resource options is provided in Figure 5-10. Storage resources offer a very low levelized cost of capacity while having a high levelized cost of energy because they offer dispatchable on-demand energy. Renewable energy projects without storage are the reverse, typically having a high levelized cost of capacity as ensuring dispatch in the P5 critical winter hours requires significant overbuild. Baseload resources offer higher levelized cost of capacity compared to storage options but comparatively less expensive than strictly renewable resources due to higher capital costs.

Figure 5-10: Comparison of the Levelized Cost of Capacity (LCOC) across supply-side resource options



ii. Federal Resource Options through BPA

BPA offers three different power products under the current regional dialogue: Load Following, Block and Block/Slice.

The **Block product** provides a planned amount of firm power to meet planned annual net load. The block product gives a set amount of power in each hour in either a flat annual block shape or a block shaped to the forecast load minus resources. When shaped, the block can vary between heavy and light load hours and by month. The PUD does not have sufficient owned or contracted resources to be a BPA Block customer without a significant cost impact. As a result, Block was not studied in the 2023 Update. There are ongoing discussions about how a redesigned Block product, to include some shapeable capacity could be offered in the Post-2028 BPA contract, but without clear information about what that

product could look like at the time of analysis for the 2023 Update, it was not possible to model it for consideration in this study.

The **Slice/Block product** is a composite of two distinct power products. The block portion is similar to the standalone Block product, with monthly energy volumes determined by load. All hourly deliveries are equal throughout the month, though each month's volume is different. Block amounts are calculated as the difference between the annual net requirements load and the firm slice amount. The slice portion of the power product represents a federal system sale including firm requirements power, hourly scheduling, and environmental attributes but not operational control. This is the BPA product the PUD currently contracts for, and one of the features helpful for the PUD is the Slice portion of the product's ability to be ramped up and down to efficiently integrate renewables such as variable wind.

The **Load Following product** provides firm power service to meet customer load minus dedicated resources, with BPA assuming load service planning responsibility for peak loads. This product is scheduled by BPA to serve load, but requires separate service with additional cost to integrate renewable resources. It is this separate cost, along with the cost of the product that is the reason the PUD has not taken this product in the current contract or switched to this product during the course of the current contract. However, as the Post-2028 contract and products are refined, the PUD will continue to evaluate whether this product could produce the lowest cost of service for PUD customers. This product was evaluated in the 2023 Update but was not found to be more cost-effective than Block/Slice under a range of scenarios. That analysis is provided in Section 6.

iii. Tier 2 Resources

The 2023 Update forecasts that the PUD will have above rate period load in the Post-2028 period and will be able to request BPA Tier 2 service. Tier 2 service comes in two options: "Long-term" Tier 2 backed by physical resources and accompanied by environmental attributes or "Short-Term" Tier 2, backed by market purchases at more volatile market prices. The PUD expects to be eligible for over 350aMW of Tier 2 by 2045, but set a cap in optimization models at 200aMW of "Long-Term Tier 2". It is expected that the PUD would hit this cap in 2039. At that point, the PUD could choose to access "Short-Term" Tier 2 if market prices were low, or develop additional renewable resources. The 2023 Update assumes the PUD would develop additional renewable resources, but the PUD will retain this optionality and respond to market and policy conditions. The PUD modeled the cost of "Long-Term" tier 2 as being a 50/50 mix of wind and solar energy developed without tax credits and with a $15/MWh Resource Support Service cost adder in order to conservatively estimate potential prices. In every scenario run, the maximum amount of long-term Tier 2 was selected. This is driven by the efficiency of the resource additions. Tier 2 is only accessible once the PUD qualifies for it, as load grows. This means the PUD accesses clean energy in efficient, incremental amounts, which can be more economically efficient than building blocks of wind or solar in 25MW or 50MW increments ahead of load, even if the PUD could develop these resources at a lower cost than BPA. More discussion is provided in Section 6 and Section 7.

6. Portfolio Development and Analysis

After the resource need has been identified and the resource options have been defined, the last process of integrated resource planning is optimizing combinations of existing and future resources to discover the lowest reasonable cost portfolios under different scenarios. Consistent with the requirements in RCW 19.280.030 the goal of the analysis identifying the best mix of supply and demand side resources that, using least cost criterion, meet current and future needs within a long-range assessment.

A. Methodology

An in-house portfolio optimization model was developed to solve for the lowest reasonable cost portfolio that satisfied all planning standards and constraints in the 2021 IRP. The same model methodology was used to construct the portfolios for each scenario in the 2023 IRP Update. Each portfolio was evaluated under both expected conditions and adverse conditions. The scenarios identified impacts and tested the resilience of each portfolio.

The portfolio optimization process creates an incremental portfolio resource buildout for each scenario based on the two most constraining metrics of P5 HLH and P5 PW metrics as described in section 4 of this document. Section 7 of this document goes into greater detail on the specific resources that are in the preferred portfolio, as well as the timing of when those resources are optimally incrementally added.

B. Key Findings

Each portfolio buildout has commonalities upon which a resource strategy should be based regardless of load growth trajectory as defined in the scenarios. Currently, BPA's Block and Slice products are the most cost-effective fit for the PUD's current and future portfolio. However, as BPA negotiates its Post-2028 power contract, the costs and attributes of Block and Slice may change requiring further analysis at that time. This contract uncertainty also means, that the commitment to, and implementation of, a long-term Resource Strategy must be flexible to accommodate potential changes in a Post-2028 BPA contract and product mix.

Key findings in portfolio optimizations across scenarios include:

1) **Conservation investment is cost-effective in all scenarios.** In higher load growth scenarios, meeting the relative increase in demand requires more incremental conservation investment.
2) **Time-of-Day rates programs are cost-effective in all scenarios**. Certain technology-based demand response programs were also found to be cost-effective in all scenarios.
3) **BPA Tier 2 power is cost-effective in all scenarios.**
4) **Battery storage is cost-effective in all scenarios.** The total nameplate amount and incremental deployment schedule fluctuate accordingly depending on the load growth scenario.
5) **Utility-scale renewables are a cost-effective way to serve load**. The total nameplate amount and incremental deployment schedule fluctuate accordingly depending on the load growth scenario.
6) **Small modular reactors (SMRs) and/or Fusion were found to be cost-effective toward the last years of the IRP's study period**, starting around 2040.

7) **The PUD must rely on limited, bilateral, short-term structured market options for the first three years of the study period.** This allows time for the PUD to procure or develop its own long-term physical resources and demand-side programs.
8) **The PUD will have to procure additional renewable energy credits (RECs) beyond the amount created from the incremental resource buildout in all scenarios through 2030.** These RECs will be used to comply with Washington State's Energy Independence Act renewable portfolio standard (RPS). The additional REC purchases are not expected to be necessary in 2030 and beyond as the PUD due to expectations the PUD will meet RPS compliance through the 100% carbon-free compliance pathway provided by the Clean Energy Transformation Act.
9) For the portfolio buildout that examined BPA's Load Following product, only conservation and a limited number of smart-rates programs were found to be cost-effective.

C. Low Case Portfolio

The low load growth scenario requires fewer overall incremental resource additions, due to lower load to serve. Below are figures 6-1 and 6-2, which show the incremental cost-effective resource buildout for the P5 HLH energy metric and P5 PW capacity metrics respectively. In the chart "Inc EE" refers to incremental EE above the baseline of conservation identified in the 2021 IRP. There is a low amount of "Inc EE" in the low case scenario.

Figure 6-1: Low Case HLH Resource Need and Additions

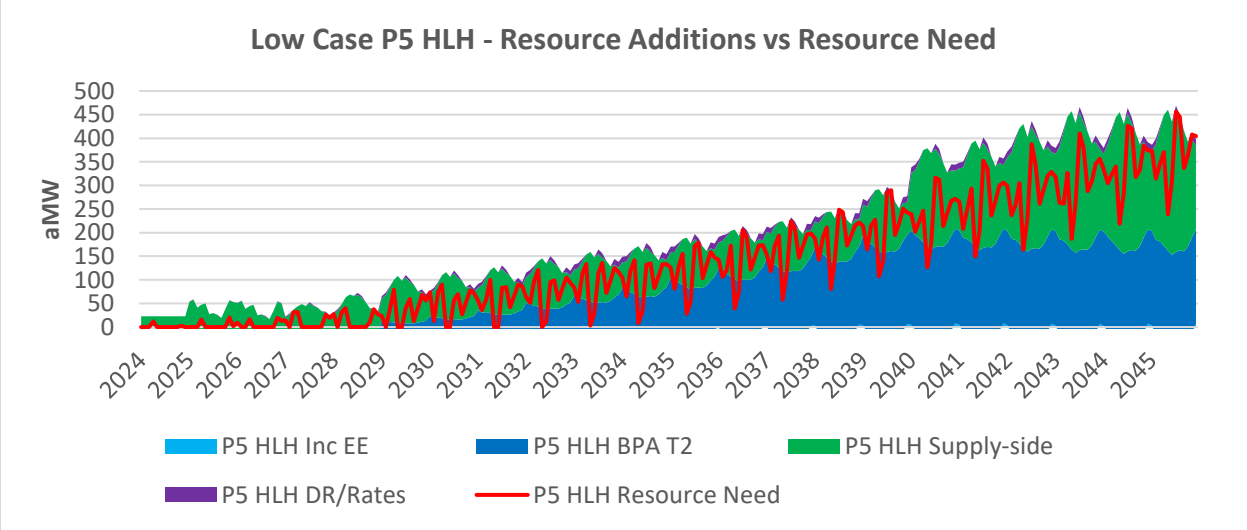
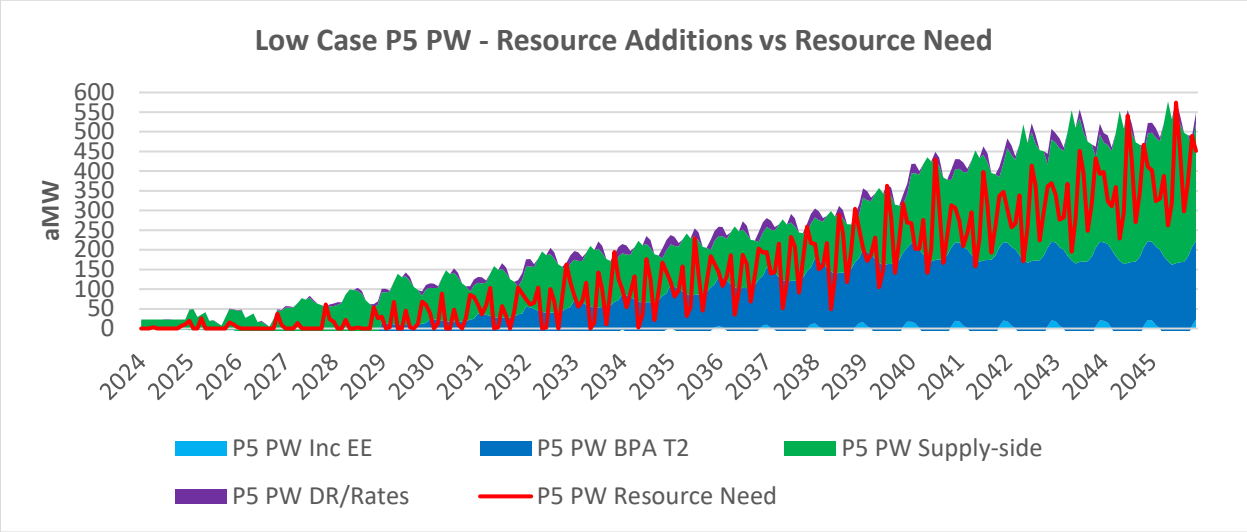


Figure 6-2: Low Case Peak Week Resource Need and Additions



D. Base Case Portfolio

The base case scenario falls between the high and load growth scenarios with respect to new resource need. It also serves as the basis for the Long-Term Resource Strategy, and many more details about its construction are provided in Section 7. The Base Case scenario requires a relatively modest amount of new resource additions to serve increasing incremental load growth. Once the lowest-cost portfolio was identified through optimization, additional sensitivity analysis was performed specifically for this scenario to test market risk against the identified resource portfolio. The Base Case portfolio solution performed better across other market price environments than alternative portfolio constructions optimized from other price threads. This is the basis for the Long-Term Resource Strategy described in Section 7.

Below are figures 6-3 and 6-4, which show the incremental cost-effective resource buildout for the P5 HLH and P5 PW metrics respectively.

Figure 6-3: Base Case HLH Resource Need and Additions

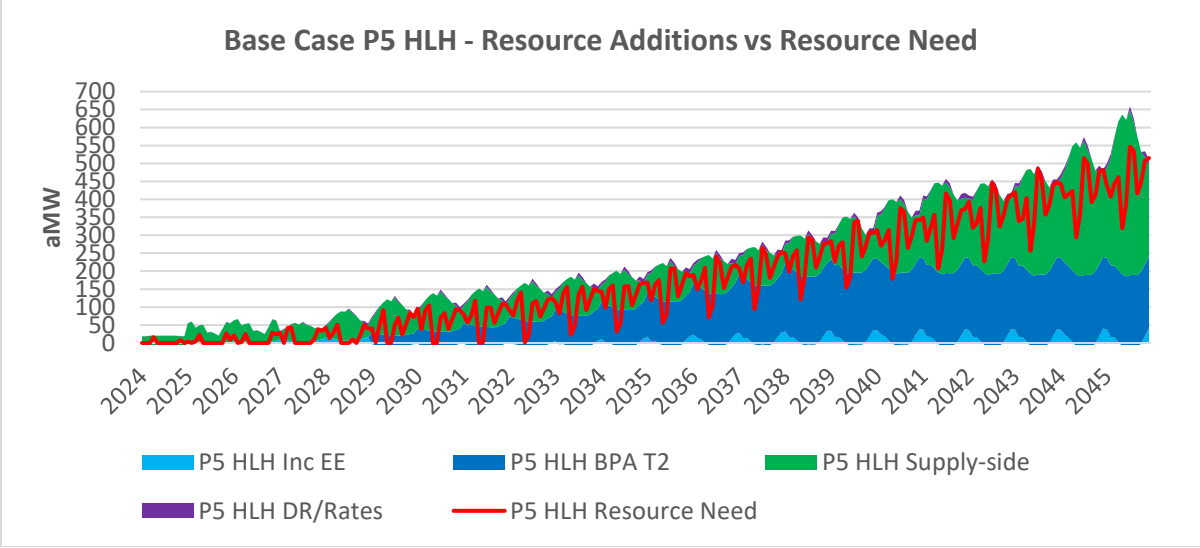
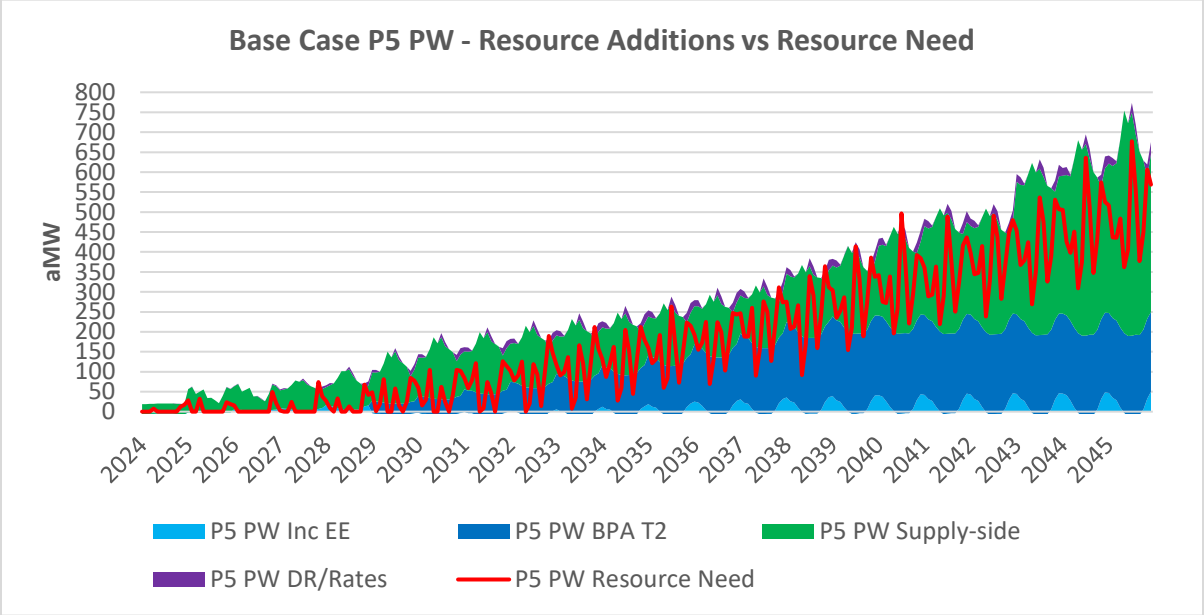


Figure 6-4: Base Case Peak Week Resource Need and Additions



E. High Case Portfolio

The high load growth scenario requires the most overall incremental resource additions to meet the increased net incremental load. New renewable and storage resources are added in significantly higher relative quantity, particularly in the last third of the IRP study period. Below are figures 6-5 and 6-6, which show the incremental cost-effective resource buildout for the P5 HLH and P5 PW metrics respectively.

Figure 6-5: High Case HLH Resource Need and Additions

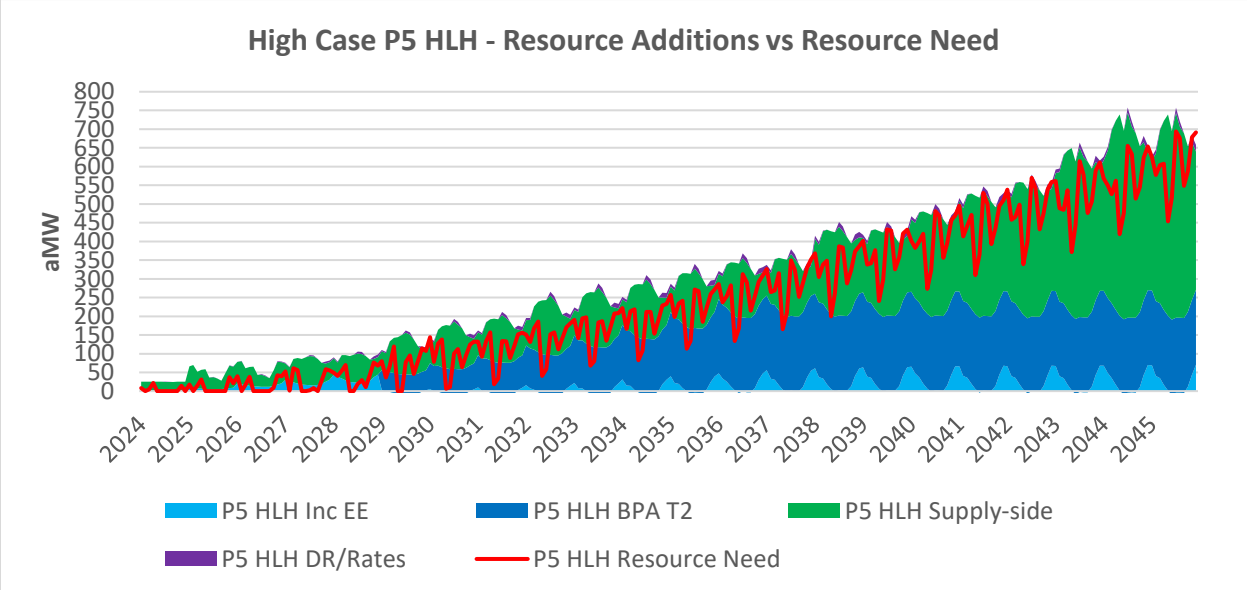
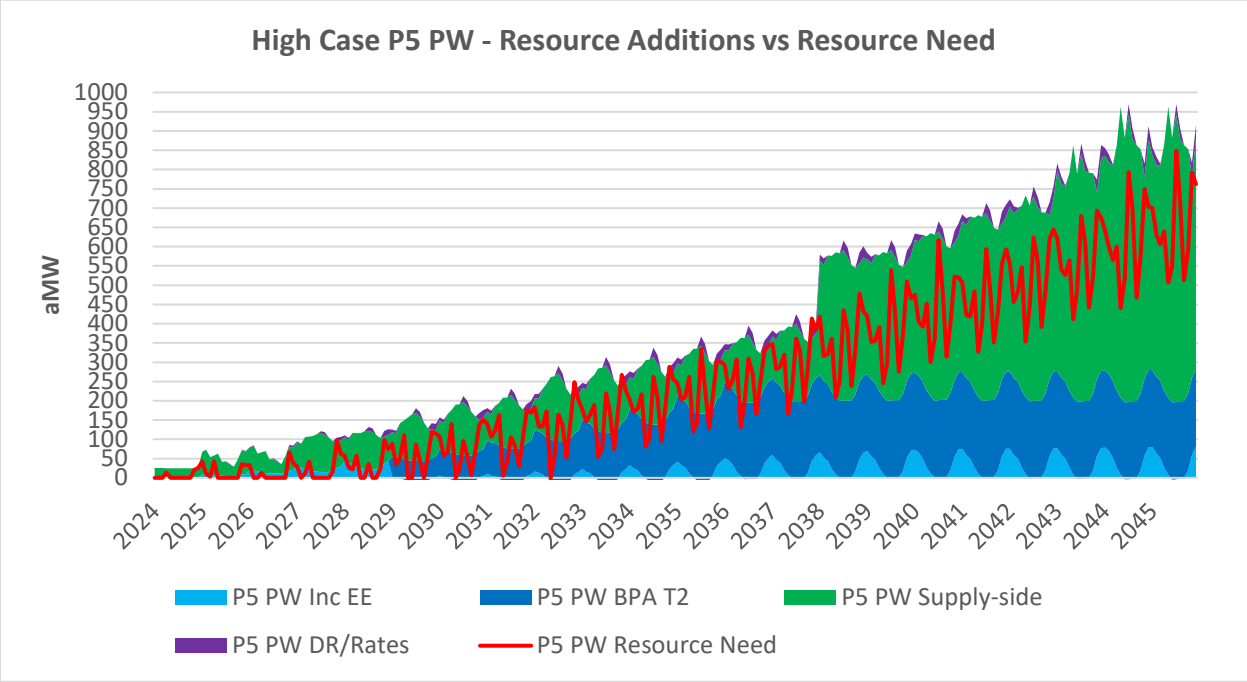


Figure 6-6: High Case Peak Week Resource Need and Additions



F. BPA Load Following Product Analysis

Figure 6-7 below shows the cost differential between the two BPA product portfolios for the PUD. BPA's load following product was analyzed as a potential way to solve for future resource need in this 2023 Update. In all, the Load Following portfolio costs approximately $550 million dollars more than the Block and Slice portfolio with current information available. The Load Following product has very similar costs to the PUD but lacks an allocation of wholesale electricity surplus and associated RECs. As such, approximately $510 million dollars of wholesale electricity revenue is not realized and regulatory compliance costs increase by approximately $97 million dollars over the study period. Capacity however is built into the product, making PUD WRAP compliance significantly less expensive by approximately $80 million dollars. This analysis will be revisited when more complete details from the Post-2028 BPA contract negotiation are available.

Figure 6-7: Block and Slice versus Load Following Cost Stack

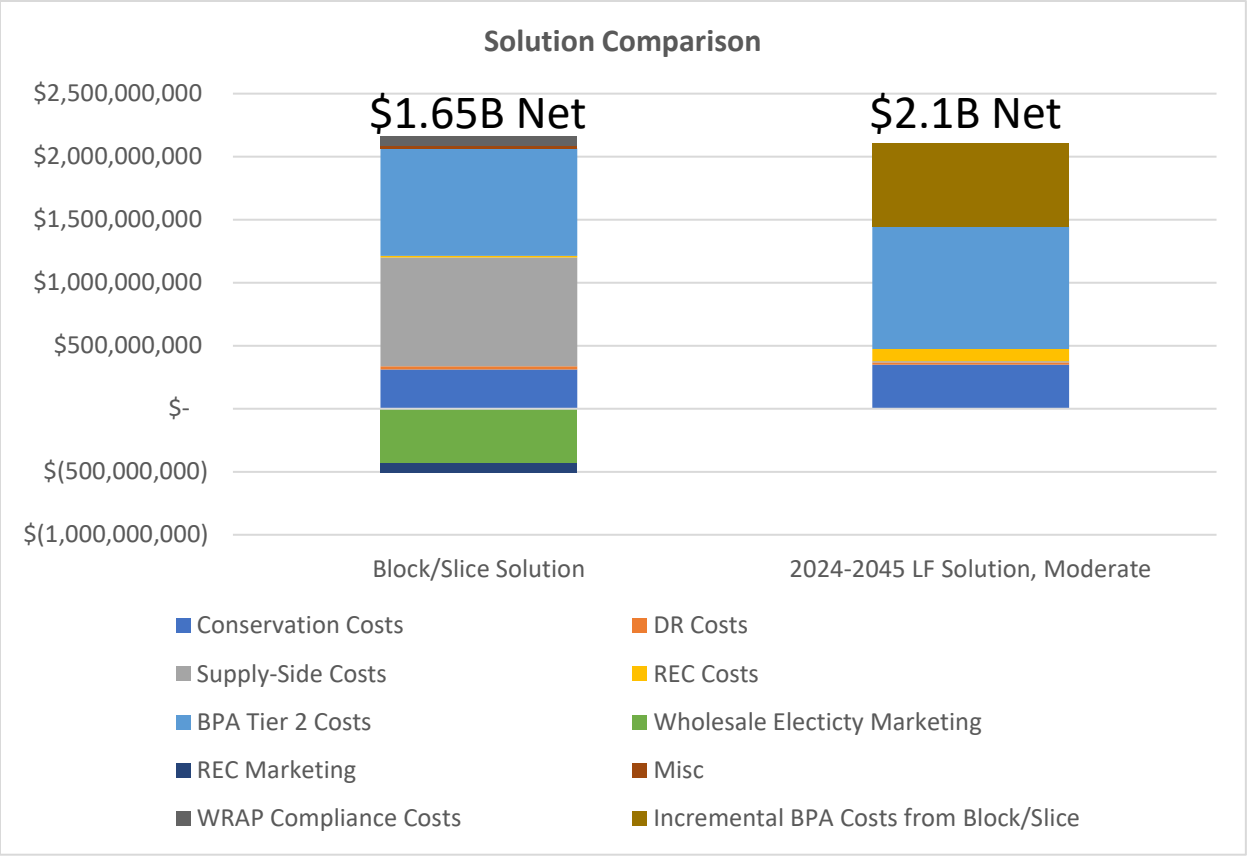
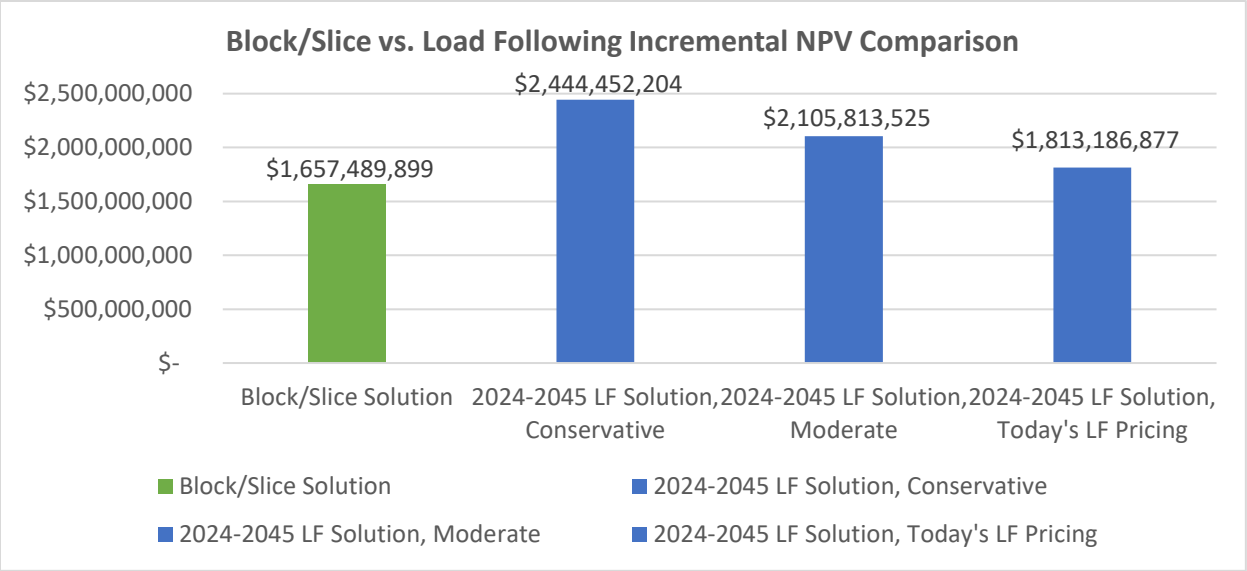


Figure 6-8 below shows the net present value of the preferred portfolio using BPA's Block and Slice products versus various load following portfolio costs run as scenarios on the possible rate structure of the BPA Load Following product. The results show that Block and Slice meet the PUD's long-term portfolio needs in a more cost-effective manner than several possible iterations of the Load Following product. The Long-Term Resource Strategy in Section 7 of this 2023 Update therefore assumes a Block and Slice product. PUD staff will continue to perform analysis on BPA products as information becomes available in the contract negotiation process.

Figure 6-8: Block/Slice Remains Preferred Strategy



7. Long-Term Resource Strategy

A Long-Term Resource Strategy must reflect and balance the potential for risk and uncertainty while identifying the best portfolio using least cost criterion. An effective Long-Term Resource Strategy must also be able to meet expected needs and effectively pivot if future technology, market, or regulatory changes create new challenges or opportunities for the PUD.

A. Key Considerations

While a Long-Term Resource Strategy is identified quantitatively through economic analysis, it can also be evaluated qualitatively in terms of the key risks, opportunities, and organizational goals of the PUD. The following key considerations represent additional lenses for viewing a long-term resource strategy.

1. Post-2028 Contract and Product Uncertainty

The PUD's long term power contract with BPA expires in 2028 and the Long-Term Resource Strategy must be flexible enough to meet customer needs in any potential post 2028 product environment. Without prescribing or determining the PUD production decision in the post-2028 contract, the 2023 Update evaluates the Resource Strategy under different product environments. Because the final BPA product details are undetermined at the time of writing, assumptions were required for various product choices and attributes. The 2023 Update used these assumptions to examine all BPA products when evaluating the proposed Resource Strategy. Resource additions beyond the BPA products were also evaluated for feasibility under other BPA product options.

2. Electrification Need

The PUD is forecasting growing loads under all scenarios in the 2023 Update due to electrification of transportation and building heating and cooling. Building electrification encompasses a larger proportion of all electric new construction and conversions from fossil fuel to electric energy sources. A

long-term resource strategy needs to be flexible and capable of serving increased load as customers move to higher electric energy needs.

3. Policy and Market Price Environment Uncertainty

Organized markets are developing in the western United States creating both risks and opportunities. Resources located within Snohomish County provided additional benefit in an organized market framework by mitigating transmission congestion rent risk and reducing the cost of bidding load into the market. How an organized market might function in tandem with a resource adequacy program must also be considered.

The PUD used 3 possible price environments reflecting higher volatility and uncertainty in regional resource buildouts. Resources that perform well in any given market price environment are preferred and the lowest cost portfolio across price environments is ideal. Physical clean resources reduce market exposure by reducing market purchases and any associated potential carbon content. Energy storage is valuable in a high price volatility environment.

4. Technology Innovation

The electric energy sector has seen rapid development and adoption of new technology on both demand and supply sides. The cost of energy storage has dramatically decreased while project longevity has increased. Renewable generation sources are widely deployed, more mature, and produce electricity with greater efficiency. New emerging technologies are under development across the industry. The PUD's Long-Term Resource Strategy must be flexible in order to access price and capability advantages of new and maturing technology. This flexibility would likely include diversification across planned resource investments and multiple time horizons.

5. Transmission Constraints

The Pacific Northwest faces increasing transmission system constraints. The PUD's transmission portfolio, which is held via contract from BPA has defined limits. Any significant resource additions outside of the service territory will come with additional transmission expense. The financial costs of new transmission for resources outside of the service territory is added to the full cost of resource ownership as a consideration in the economic optimization model. Physical transmission risk also considers the availability of the transmission line to bring energy into the PUD's service territory. New resources developed outside PUD service territory also carry a physical delivery risk if transmission pathways are constrained. Furthermore, project development is often dependent on transmission access or buildouts that take significant time to come to fruition.

6. Community Values, Company Values, and Public Feedback

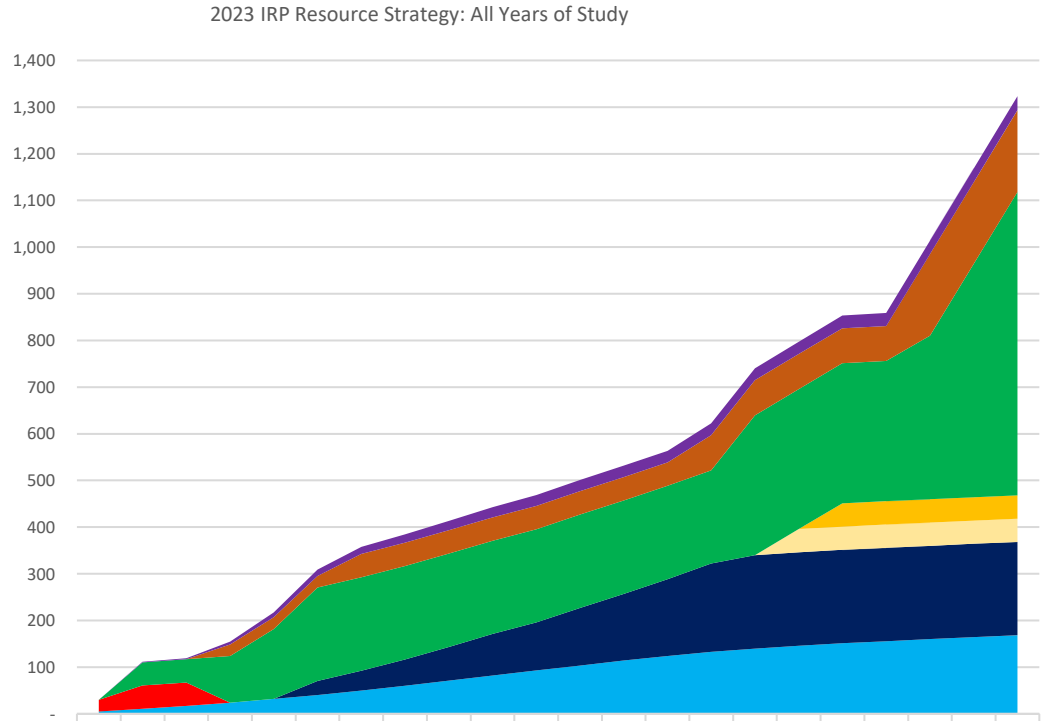
Snohomish PUD has a long-standing commitment to conservation and clean energy sources, and its customers have voiced support for continuing this approach in public venues. A resource strategy that utilizes resource investments within Snohomish County may provide customers and the community more public benefit than a resource strategy where more investments are made outside Snohomish County and Camano Island. Energy efficiency, demand response, and locally sited energy storage resources all represent resource investments in PUD communities. PUD staff engaged with the public frequently during the scoping and development of the 2023 Update, and that feedback was important in shaping this study. The public process for the 2023 Update is summarized in Section 8A.

B. Long-Term Resource Strategy

The proposed Long-Term Resource Strategy for the 2023 Update utilizes the base case scenario and contains the resources identified by economic optimization. These resources represent the most cost-effective portfolio for satisfying all relevant planning standards and regulatory requirements while remaining flexible through the BPA 2028 contract negotiations. The 2023 Long Term Resource Strategy also sets the biennial conservation targets for 2024 and 2025. This Resource Plan anticipates future resource development recognizing that the PUD will continue to evaluate its needs in future IRPs.

Figure 7-1 displays the entire Long-Term Resource Strategy.

Figure 7-1: Long-Term Resource Strategy -All Years of Study Period



	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
DR/Rates (PW aMW)	0.24	1.04	2.60	6.18	10.7	13.2	15.6	17.8	19.7	21.6	23.2	23.8	24.3	24.8	25.4	25.9	26.5	27.2	27.8	28.5	29.2	30.0
Li-Ion 4-hr Battery (MW)	-	-	-	25	25	25	50	50	50	50	50	50	50	50	75	75	75	75	75	175	175	175
Utility-scale Renewables (MW)	-	50	50	100	150	200	200	200	200	200	200	200	200	200	200	300	300	300	300	350	500	650
SMR (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	50	50	50	50
Fusion (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	50	50	50	50	50
BPA Tier 2 (Annual aMW)	-	-	-	-	-	30	42	56	73	89	103	124	143	165	189	200	200	200	200	200	200	200
Market (MW)	25	50	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cumulative EE (Annual aMW)	5.00	10.5	16.8	23.8	31.7	40.4	49.9	60.2	70.9	81.8	92.8	103.	114.	123.	132.	139.	145.	151.	155.	159.	164.	168.

Near-Term Resource Strategy

Near-Term Actions can be considered the actions the PUD expects to take in the next 2-3 years to augment its existing resources and serve load cost-effectively.

Cost-Effective Conservation	Time-of-Day Rate Options	Energy Storage	Short-Term Market Contracts	Post-2028 Contracts
•**Cost effective conservation** remains a key component of the PUD's long term resource strategy and provides the PUD with significant value. Conservation has been a consistently sound investment for the PUD for several decades. The analysis from the 2023 Update confirms this value and plans for significant additional investment over the study period. ***The biennial conservation target for 2024-2025 is 10.54 aMW.***	•**Time-of-Day rate options** provide participating customers more control over their bills and allow the PUD to incentivize demand shifts from higher-cost periods to serve to lower-cost periods. The PUD is planning new options for customers in parallel with the roll-out of advanced meters that will make these rate options possible. ***The 2023 Update targets a modest 1aMW of average peak reduction by 2025, in line with forecasts for advanced meter rollouts and customer engagement processes.***	•**Energy Storage** resources position the PUD well under multiple BPA product options: they provide organized market functionality, contribute to resource adequacy needs and reduce transmission risk. ***The 2023 Update assumes the 25MW battery currently undergoing procurement will be online by October 2025. It also suggests that the PUD should be pursuing additional due diligence on potential sites, procurement strategy and distribution system needs for additional storage investments.***	•**Short-term market contracts** serve primarily as a bridge to meet forecast resource-load gaps until long-term demand and supply-side resources come online. Long-term resources and demand-side programs take time to construct, develop, and implement. ***The 2023 Update targets 50MW of additional short-term market contracts from 2024-2026.***	•**PUD staff must negotiate for cost-effective Post-2028 BPA Power Product options** and evaluate the best fit for customer needs. This process began in 2021, and is expected to continue through 2024, with contract execution in 2025. The PUD must remain flexible and open to product alternatives through this process. It is expected that the Block/Slice product works best for the PUD with the information today, but staff will continue evaluating all options.

i. Mid-to-Late-Term Needs and Optionality

Once BPA contract negotiation is complete with fully realized product details and Tier 1 allocations, the PUD can address future needs with less risk given the certainty around BPA product investments. At the time of writing the preferred BPA product is the Block/Slice solution and the Long-Term Resource Strategy is reflective of that product choice. The PUD's long term resource needs are as follows:

1. Conservation

Conservation provides the foundation for the PUD's resource plan, providing multiple value streams for meeting portfolio needs. Conservation provides the PUD value by reducing load that otherwise would have occurred during peak hours, thus reducing capacity needs. Conservation also reduces pressure on the PUD's current portfolio of generating resources. Further, conservation reduces load associated with regulatory obligations for the EIA and CETA, resulting in decreased regulatory costs. The cumulative conservation targets are given in the table below and are expressed in Annual aMW.

2025 (2-Year)	2028 (5-Year)	2033 (10-Year)	2038 (15 Year)	2043 (20 Year)
10.54	31.73	81.84	132.69	159.98

2. Demand Response

Demand Response and the development and adoption of Time-of-Day rate programs provides the PUD with low-cost resources to meet time-limited capacity needs. The development of these programs is highly contingent upon the timing, rollout, and leveraging of the PUD's Advanced Metering Infrastructure (AMI) program. That infrastructure will facilitate developing the lowest cost load-shifting programs.

A comprehensive Demand Response Potential Assessment was developed in support of the 2023 Update. While AMI provides the capability and infrastructure to take advantage of many Demand Response programs, the technical potential of these programs is not forecast to meet all of the PUD's capacity needs, necessitating the acquisition of additional resources. The PUD's two-year, four-year, and ten-year demand response and smart rates targets (combined as DR targets) are given in the table below and are expressed in Peak Week aMW.

2025 (2-Year)	2028 (5-Year)	2033 (10-Year)	2038 (15 Year)	2043 (20 Year)
1.04	10.75	21.61	25.41	28.55

3. Energy Storage

Battery energy storage has been identified as the utility-scale resource acquisition best able to meet the size, seasonality, and persistence of the PUD's long-term capacity needs. As Washington utilities act to comply with CETA, the expected market impact of those actions creates significant value for energy storage. Downward pressure on average market prices decreases the cost of charging a storage project. Increased hourly price volatility provides increased opportunity for charging storage at low prices.

Further, as the Pacific Northwest's regional resource mix becomes incrementally cleaner under regional clean energy policies, the storage inputs would also be expected to have lower carbon content over time. The emerging WRAP metrics provide a high qualifying capacity contribution for all energy storage with 4-hour duration or more, allowing Li-ion battery technology to significantly contribute to WRAP

compliance needs. Cumulative battery nameplate targets are given below and are incremental to the current 25MW project under development.

2025 (2-Year)	2028 (5-Year)	2033 (10-Year)	2038 (15 Year)	2043 (20 Year)
0	25	50	75	175

4. Utility-Scale Renewable Energy

PUD demand is expected to exceed its existing resource portfolio in the mid to late study period and the PUD will need to acquire significant energy resources. These resources are a mixture of utility scale solar, wind, solar plus storage, and wind plus storage. Adding utility scale renewable resources helps meet the PUD's P5 HLH planning standards, Energy Independence Act and CETA compliance targets. The PUD's existing wind fleet contracts are retiring in the 2020's and the mid-term resource strategy acquires replacement renewable resources with the most modern technology. As load growth increases later in the study period, additional resources will be acquired as the PUD outgrows its BPA Tier 2 allocation. Cumulative utility-scale renewable nameplate targets are expressed in MW in the table below.

2025 (2-Year)	2028 (5-Year)	2033 (10-Year)	2038 (15 Year)	2043 (20 Year)
50	150	200	200	350

5. BPA Tier 2

The PUD is expected to be eligible for BPA Above High Water Mark load service, or Tier 2 power in the Post-2028 contract. Long term Tier 2 service grants the PUD a glidepath to the 2030's and provides a pivot point in the early 2030's to new resources or further short-term Tier 2. Furthermore, long-term Tier 2 is backed by physical resources and will provide environmental attributes for clean energy compliance requirements. The PUD will need to make an election on long-term Tier 2 in the Post-2028 contract. Whatever product the PUD selects will require significant Tier 2 elections, though this volume is expected to be lesser under the preferred Block/Slice due to other renewable energy investments the PUD would plan to make. The cumulative BPA Tier 2 targets are expressed below in Annual aMW.

2025 (2-Year)	2028 (5-Year)	2033 (10-Year)	2038 (15 Year)	2043 (20 Year)
0	0	89	189	200

6. Fusion and SMR

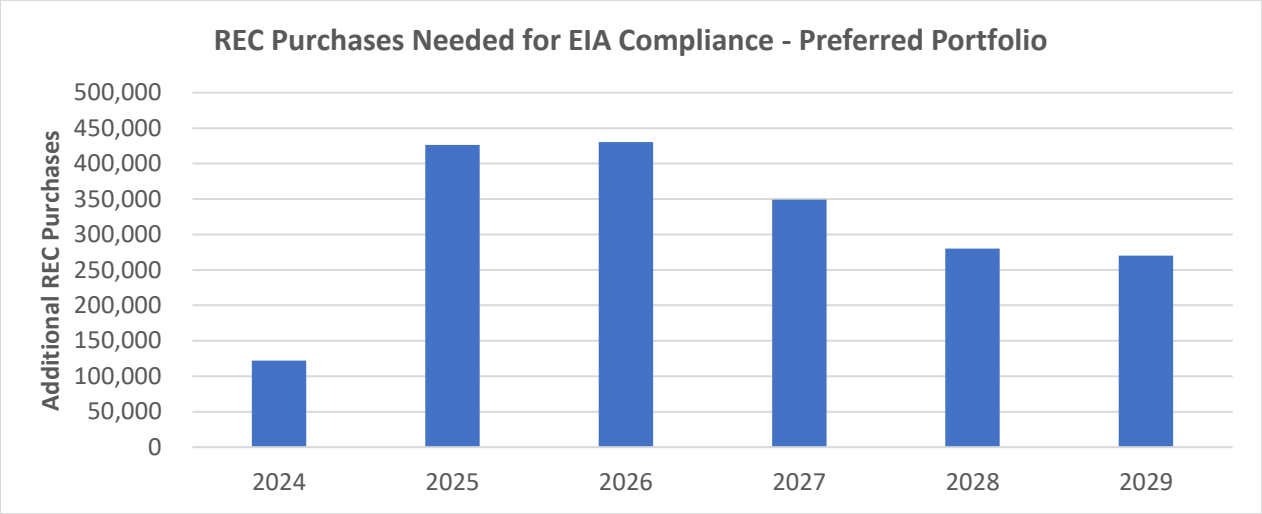
Fusion and Small Modular Reactor resources are not available until later in the study period and their commercial availability is not guaranteed. The PUD will continue to monitor the development of SMR and fusion projects and adjust the long-term resource plan accordingly. The PUD will continue to develop collaborative relationships with local fusion manufacturers and regional SMR partners as the projects are progressing. The nameplate targets are expressed in MW in the table below.

2025 (2-Year)	2028 (5-Year)	2033 (10-Year)	2038 (15 Year)	2043 (20 Year)
0	0	0	0	100

ii. Regulatory Compliance Considerations

The Energy Independence Act (EIA) mandates that the PUD meet certain renewable portfolio standards. In the preferred portfolio, without purchasing additional RECs the PUD would not meet its compliance targets year over year until 2030. Figure 7-2 below shows the REC purchases needed to fully comply with the EIA.

Figure 7-2



8. Technical Appendix

A. Public Process

The PUD utilizes an extensive public process to inform the development of long-term plans, and has a customer-centric approach to planning. The public processes are intended to understand the perspectives of customers, incorporate analysis of interest to customers, and provide transparency for customers throughout the planning process.

IRP Open House - 02/23/2022

On February 23, 2023 the PUD hosted an IRP open house with approximately 25 members of the community and staff representing Power Supply, Government Relations, Energy Services, Communications and Marketing, Rates, Economics and Energy Risk Management. The intent of the open house was to provide the public an opportunity to learn the PUD's IRP process and provide input on the proposed scope of IRP analysis. The meeting started with a welcome by PUD Assistant General Manager of Generation, Power Supply, Rates and Transmission Management Jason Zyskowski thanking our customers for joining and introducing the staff. The first portion of the meeting consisted of a presentation by Power Supply Staff introducing the IRP and presenting the proposed scope, while the second half was a Q&A session intended to provide an open forum for comments and questions .

Customer feedback included the following (paraphrasing used here for clarity and brevity):

a. The PUD should evaluate whether incentivizing rooftop solar could result in cost savings for all customers.
b. The PUD should continue to engage in state and federal policymaking, to safeguard the interests of its rate payers.
c. The PUD should seriously and critically evaluate whether it can have the scale of resources needed for electrification with special respect to the potential development timeline of new resources.
d. The PUD should continue to evaluate the potential impact of changes to federal dams.
e. The PUD should do more, not less, customer engagement on long-term planning efforts and seek broad participation.
f. The PUD should seek to continue to secure its critical infrastructure from attacks such as those that were recently experienced add substations in Tacoma and elsewhere.
g. The PUD should continue to prioritize conservation as a potential resource, including measures like weatherization.
h. The PUD should evaluate the impacts of carbon emitting resource retirements in the Pacific Northwest and its potential impact on the PUD.

As a result of this feedback, the PUD evaluated whether a one-time upfront payment for rooftop solar could be cost-effective in the 2023 Update. While it was not found cost-effective, an Action Plan item focuses on a commitment to best-practice processes for enabling customer solar to ensure interconnection processes continue to work well for customers. In addition, the PUD conducted extensive analysis on load service needs for electrification in the 2023 Update. The PUD intends to perform sensitivity analysis on changes to federal dam operations in the comprehensive 2025 IRP, as it is expected that analysis will require new computational models not available in time for the 2023 Update.

Power Talks - 03/09/2022

The PUD hosts regular virtual meetings open to customers on specific topics called PowerTalks. These PowerTalks offer an online format to engage with customers that may be harder to reach in person. In March the topic of PowerTalks was "How your PUD is planning for the future". Garrison Marr, Kris Scudder and Landon Snyder joined to give an overview of the IRP process, the core questions of this IRP and the timeline of the 2023 IRP. PUD customers and staff were attending the webinar and had time at the end of the presentation for questions. Customer questions were on

a. The availability of demand response and if connect up smart meters were required
b. The energy profile of the PUD's power supply during peak events
c. If the PUD had rooftop solar in its plans
d. How market purchases factored into the PUD's plans
e. Did the PUD plan for hydrogen energy storage
f. What is the price of BPA Tier 1 energy vs the alternatives

As a result of customer feedback, the 2023 Update includes demand response analysis, peak load profile analysis and charts, incorporation of rooftop solar in load forecasts and analysis of a one-time upfront rooftop solar incentive, market purchase evaluation and economic analysis of BPA Tier 1 power. Hydrogen energy storage was not assessed in the 2023 Update due to a lack of commercial data on available projects, but will be re-assessed in the 2025 IRP.

Energy Block Party - 04/22/2022

The PUD hosted an Energy Block Party street fair style event with many booths where PUD staff could interact with customers in a conversation. The IRP team hosted a booth at the Energy Block Party and customers were given an opportunity to ask questions about the future PUD power supply and the planning process. Customers visited the booth to get an abbreviated description of the 2021 IRP document and gave feedback on the issues facing the PUD. Customers indicated support for rooftop solar programs, evaluating new and emerging technologies and the value of carbon free energy.

Commission Briefings – Various

PUD staff provide briefings during the development of the IRP to provide Commissioners an opportunity to provide feedback, and for additional public transparency of the process. PUD staff break the IRP process into 5 phases, and these phases are shared sequentially (sometimes in groups). These Phases are as follows:

- Phase 1: Definition of study scope
- Phase 2: Calculation of resource need given load and resource forecasts
- Phase 3: Evaluation of Resource Options, including cost and capability
- Phase 4: Portfolio Optimization
- Phase 5: Resource Strategy and Action Plan

<u>Briefing 1: January 24, 2023</u>

This briefing kicked off the 2023 IRP Update process, with staff presenting initial ideas on the 2023 Update scope, the overall timeline, and proposed public process.

<u>Briefing 2: July 25, 2023</u>

PUD staff presented the results of phases 1 through 3 to commissioners. The phase 2 results described increased needs due to increasing load while the phase 3 briefing described the supply side resources to be considered and available conservation as given in the 2023 CPA. Commissioners were also briefed about the market price environment and the approach taken in the 2023 Update.

Briefing 3: October 2, 2023
The third briefing discussed the phase 4 results, and the phase 5 resource strategy was described. The commissioners were briefed on the inclusion of BPA Tier 2 in the Long-Term Resource Strategy and the flexibility Tier 2 provides for the PUD. The analysis of the Load Following product and the PUD's preference for Block/Slice was also presented, including the projected costs associated with each product choice.

Briefing 4: November 21, 2023
The fourth briefing will present the proposed final 2023 Update, biennial conservation targets, and action plan.

IRP Open House – November 2, 2023
The Draft 2023 Update will be released on October 30, 2023 and an Open House is planned for November 2, 2023. The purpose of the Open House is provide an overview of the Draft 2023 Update, to communicate how earlier public feedback was incorporated, and to solicit questions and feedback from customers to help inform the final version of the 2023 Update, which is intended to be presented to the PUD Commission on November 21, 2023 and is scheduled for consideration of adoption on December 7, 2023.

B. Regulatory Compliance

The purpose of this section of the Technical Appendix is to provide a concise crosswalk across regulatory requirements found in Washington State statutes and Administrative Code, and how those requirements are satisfied by the 2023 Update.

i. Energy Independence Act (Conservation)

Conservation acquisition is addressed in both the Conservation Potential Assessment and the IRP. The CPA highlights areas that are accomplished through the CPA modeling process, and this appendix provides more detail on how remaining conservation planning elements are included in the IRP.

WAC 194-37-080 Section	Requirement	Implementation
(5)(c)	**Economic achievable potential**. Establish the economic achievable potential, which is the conservation potential that is cost-effective, reliable, and feasible, by comparing the total resource cost of conservation measures to the cost of other resources available to meet expected demand for electricity and capacity.	The PUD uses its IRP optimization model to determine what measures are cost effective by comparing the costs and benefits of conservation measures against other resources. See Section 6: Portfolio Development for more details.
(5)(d)(i)	Conduct a total resource cost analysis that assesses all costs and all benefits of conservation measures regardless of who pays the costs or receives the benefits;	The costs considered in the levelized cost include measure capital costs, O&M costs, periodic replacement costs, and any non-energy costs. Benefits included avoided T&D capacity costs, non-energy benefits, O&M savings, periodic replacement costs. Avoided energy costs, generation capacity value, and any risk premium are factored into the PUD's IRP modelling through the Portfolio Optimization process described in Section 6: Portfolio Development. Measure costs and benefits can also be found in the individual measure files as well as the "ProCost Measure Results" file in the CPA.
(5)(d)(v)	Include avoided energy costs equal to a forecast of regional market prices, which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy efficiency measures to which it is compared	The PUD incorporates regional market price forecasts as part of its IRP modelling. See Section 3: Market Price Forecast for further details.
(5)(d)(vii)	Include deferred generation benefits consistent with the contribution to system peak capacity of the conservation measure	Deferred generation capacity expansion deferral benefits are modelled through the District's IRP analysis. Hourly savings data developed as a part of this CPA enabled the PUD's IRP to evaluate

		the capacity contribution of each measure bundle with respect to the PUD's peak demands. See Section 6: Portfolio Development for further details.
(5)(d)(viii)	Include the social cost of carbon emissions from avoided non-conservation resources	The PUD's IRP modelling factors in carbon costs per the requirements of Washington's EIA and CETA. See the Section 3: Market Price Forecast for further details.
(5)(d)(ix)	Include a risk mitigation credit to reflect the additional value of conservation, not otherwise accounted for in other inputs, in reducing risk associated with costs of avoided non-conservation resources	The PUD's IRP addresses risk through probabilistic modelling. See the Section 6: Portfolio Development for further details.

ii. Energy Independence Act (Renewable Energy)

The Energy Independence Act also established a renewable portfolio standard (RPS) with renewable energy targets for utilities, in addition to other compliance mechanisms, which the Department of Commerce is tasked with overseeing on an operational basis. In order to determine the most cost-effective route to RPS compliance, the 2023 Update considers the target methodology for compliance, the No-Load-Growth compliance mechanism, and the effects on EIA requirements of CETA legislation toward 100% clean utilities. The Long-Term Resource Strategy finds a mix of these compliance methodologies across the study period to be the most cost-effective way to meet regulatory obligations and customer needs, but this is expected to be revisited in future IRP updates.

Figure 8-1 shows the volume of REC purchases forecast to be needed to complement RECs from owned and contracted renewable energy sources. Beyond 2030, the PUD anticipates being able to demonstrate the utility is served by 100% clean energy and exempt from EIA RPS requirements per RCW.

Figure 8-1: Forecast REC Purchase Needs for EIA RPS Compliance

iii. Clean Energy Transformation Act

The table below provides a summary of highlighted portions of the Clean Energy Transformation Act, how they were interpreted, how they relate to the PUD and the 2023 Update, and where in the 2021 Update more discussion can be found.

Citation	Statutory Requirement	2023 Update Treatment and References
Sec. 3 (1)(a)	Utilities must eliminate coal-fired resources from electric rates by 2026	The PUD has no coal-fired resources, is not considering contracting for coal-fired generation, and is not considering building a coal plant. This can be observed in **Section 5**'s discussion of Resource Options.
Sec 4 (1-5)	Utilities should be carbon neutral by 2030 and can use up to 20% alternative compliance mechanisms (including unbundled RECs) in order to achieve this goal.	The PUD's Portfolio Optimization tool required eligible resource generation of no less than 80% of retail load in 2030, linearly increasing to 100% by 2045. The PUD's existing portfolio contains eligible resources forecast to significantly exceed current retail load, and the PUD does not intend to add fossil fueled resources. Therefore, the PUD expects to significantly exceed the statutory threshold in all years of the 2030-2045 compliance period. The comprehensive 2021 IRP

		includes a full discussion of existing clean resources, but all incremental clean resource additions are discussed in **Section 7**
Sec 4 (6)	Utilities must pursue all cost-effective, feasible, and reliable conservation and demand response	The 2021 IRP uses the integrated portfolio approach and the portfolio development and optimization approach described in **Section 6** to arrive at the combination of available resources that results in the lowest net costs to customers while meeting reliability and regulatory standards. Feasibility is addressed in Technical Potential analysis in the Conservation Potential Assessment and Demand Response Potential Assessment that provide the supply-curve inputs into the 2023 Update.
Sec 4 (8)	Utilities must ensure all customers benefit from the transition to clean energy.	The 2023 Update uses a lowest reasonable cost approach to determine the most affordable way to meet customer's needs and reliability and regulatory standards as discussed in **Section 6**. In this way, and through the ratemaking process, the PUD ensures its resource plan provides lowest cost clean energy to customers. In addition, the Clean Energy Implementation Plan process addresses equitable distribution of benefits and provides additional context to the PUD's plans.
Sec 5	All retail sales of electricity must be from renewable and non-emitting resources by 2045.	The PUD forecasts it is on track to meet this standard by virtue of having eligible resources in existing portfolio in excess of its expected retail load, and by planning to add only eligible supply-side resources in its Long-Term Resource Plan. This is discussed further in **Section 7.**
Sec 6 (2)	Consumer-owned utilities must develop a four-year Clean Energy Implementation Plan that is informed by the utility's IRP and Clean energy Action Plan	The PUD filed a Clean Energy Implementation Plan in conjunction with the 2021 IRP, using the 2021 IRP to inform it**.** The 2021 IRP also included a Clean Energy Action Plan**.** The 2023 Update is a

		two-year update filed between regulatory obligations for 4-year CEIP and CEAP filings.
Sec 14 (f)	IRP's must contain a 10-year forecast of regional generation and transmission capacity on which the utility may rely upon to deliver energy to its customers	The PUD conducts a WECC-wide resource simulation to determine a plausible mix of resources in the Western United States and Canada that would meet regional reliability standards, as discussed in **Section 3.** In addition, the PUD sets Planning Standards for market reliance at levels expected to be below market depth and within the operating parameters of the PUD's Transmission Portfolio. Planning Standards are also discussed in **Section 3**.
Sec 14 (g)	Utility IRP's must determine resource adequacy metrics for the resource plan consistent with the forecasts	The PUD provides its Resource Adequacy metrics as its Planning Standards as described in **Section 3.**
Sec 14 (h)	Utility IRP's must forecast distributed energy resources installed by customers and their impact on load and operations	**Section 3** describes load forecasts which are inclusive of rooftop solar, and **Section 5** discusses resource options which included conservation and demand response programs.
Sec 14 (i)	Utility IRP's must identify resource adequacy metrics for use in other portions of CETA statute	The PUD provides its Resource Adequacy metrics as its Planning Standards as described in **Section 3.** The PUD uses an integrated portfolio approach to integrate all resource planning functions for the PUD, including the CEIP, CEAP, IRP and identification of economic conservation and demand response.
Sec 14 (k)	Utility's must conduct a cumulative impact analysis of energy and nonenergy benefits and reductions of burdens to vulnerable populations and highly impacted communities	This analysis is presented in the 2021 Clean Energy Implementation Plan, which is published every four years.
Sec 14 (1)A	Utility's must develop a 10-year Clean Energy Action Plan	Clean Energy Action Plan's are established every four years, and the 2021 IRP contained the last PUD Clean Energy Action Plan. However, the PUD's Long-Term Resource Plan includes a 10-

		year outlook on clean energy acquisitions along with an Action Plan in **Section 7.**
Sec 14 (3)	Utility's must use the Societal Cost of Carbon specified by the statute in the development of Clean Energy Action Plans	Clean Energy Action Plan's are established every four years, and the 2021 IRP contained the last PUD Clean Energy Action Plan. However, the PUD's Long-Term Resource Plan includes a 10-year outlook on clean energy acquisitions along with an Action Plan in **Section 7,** and the Societal Cost of Carbon was embedded in the market price forecast of the integrated resource approach used to solve for the Resource Strategy**.**

iv. Climate Commitment Act

In January 2023, Washington State began implementation of its Climate Commitment Act legislation, enacting a "Cap and Invest" program. This program establishes an economy-wide cap on carbon emissions, with allowances auctioned by the state. The program provides electric utilities with an amount of "No Cost" allowances to offset program costs because clean energy development for electric utilities is primarily regulated by the Clean Energy Transformation Act. As such, the PUD has received an allocation of allowances that is believed to fully cover the costs of the Climate Commitment Act.

In the IRP, the PUD examines resource carbon intensity as part of its economic analysis. This analysis helps the PUD ensure compliance with the various state policies and mandates regarding clean energy and utility portfolios and accounts for any potential future costs related to the Climate Commitment Act. In this Update, no additional costs are forecast as it is expected that No Cost allowances will generate sufficient revenues to offset any program costs.

v. Transmission Analysis

As part of the 2022-2023 legislative session, Washington State enacted new regulations requiring utilities to undertake additional transmission analysis. The purpose of the law is to help ensure that utilities are planning appropriately for the needs of their customers related to making sure that the energy generated by a utility's portfolio is able to be delivered.

As a local utility, the PUD only operates a distribution system – namely, the poles and wires needed to bring energy across the county and into homes at the individual level. Snohomish does not operate any high voltage transmission infrastructure as defined by the Federal Energy Regulatory Commission, and as such is not considered to be a "Transmission Operator." Instead, Snohomish fully contracts for its transmission needs with BPA, along with other small purchases as needed from other Transmission Providers.

As the largest regional Transmission Provider, BPA has an extensive transmission planning process to ensure that it is responding to and meeting the needs of its customers. The PUD participates in these

planning processes and plans to make the formal requests required by RCW 19.280.030(1)(f)(ii), however the timelines required for full inclusion in the 2023 IRP Update are not sufficient to ensure BPA's planning process aligns with the requirements of the regulation. The PUD expects that the 2025 Comprehensive IRP will contain a more thorough crosswalk between BPA planning efforts and regulatory planning requirements. For the 2023 IRP Update, the PUD would submit BPA's current transmission planning process[6] for consideration; the PUD closely monitors and participates in these processes to ensure that the PUD's transmission needs will continue to be met as the PUD moves into the future.

[6] BPA Attachment K Transmission Planning - Attachment K Planning - Bonneville Power Administration (bpa.gov)
BPA Transmission Business Model; "Evolving Grid" Strategic Planning - Transmission Business Model - Bonneville Power Administration (bpa.gov)
BPA Transmission Study and Expansion Process - TSR Study & Expansion Process - Bonneville Power Administration (bpa.gov)