# RESOURCE PLAN
## CHAPTER THREE - DRAFT

PUGET SOUND ENERGY

# Contents

# 1. Introduction

Puget Sound Energy's (PSE) preferred portfolio is the result of robust Integrated Resource Plan (IRP) analyses developed with input from interested parties. Informed by our deterministic portfolio, risk and portfolio benefit analyses, PSE's portfolio meets the Clean Energy Transformation Act (CETA) requirements.

Puget Sound Energy (PSE) is the Pacific Northwest's largest utility producer of renewable energy. We currently own and contract over 10 million MWh of renewable and non-emitting energy, which will grow to more than 30 million MWh by 2045.

Throughout the resource planning process for the 2023 Electric Progress Report (2023 Electric Report), we focused on the following key objectives, which lay the foundation for this and all future resource plans:

- Achieve the renewable energy targets under CETA — meet at least 80 percent of PSE's demand with renewable and non-emitting energy and be carbon neutral by 2030, and meet 100 percent of PSE's demand with renewable and non-emitting resources by 2045
- Build a reliable, diversified power portfolio of renewable and non-emitting resources
- Continue to be a clean energy leader in and beyond the Pacific Northwest
- Ensure an equitable clean energy transition for all PSE customers
- Ensure resource adequacy while delivering a clean energy transition
- Ensure resource planning aligns with PSE's Clean Energy Implementation Plan (CEIP) to meet our interim targets and CETA obligations

We used three distinct types of analysis to develop, refine, and identify the preferred portfolio:

1. The deterministic portfolio analysis solves for the least-cost solution and assumes perfect foresight about the future.
2. The risk analysis examines how to diversify the portfolio to address the technology risk of future resources. Stochastic risk analysis assesses the impacts of uncertainty in hydroelectric and wind conditions, electric and natural gas prices, customer demand, and unplanned plant-forced outages.
3. The portfolio benefit analysis incorporates equity into the IRP process by measuring potential equity-related benefits to customers within a given portfolio. Because the IRP process is inherently forward-looking, this analysis seeks to identify portfolios containing a mix of electric resources that can enable more equitable customer outcomes in the future. It is important to note that the IRP process in general lacks the detail to assess existing or future programs and actions addressing equity; however, the IRP process can provide a pathway towards ensuring PSE is acquiring the electric resources necessary to implement future programs and actions that are more equitable.

# 2. Resource Plan

Puget Sound Energy is committed to reaching CETA goals and achieving carbon neutrality by 2030 and a carbon-free electric energy supply by 2045. The electric resource plan reflects our path to meeting our CETA commitments. Our plan prioritizes delivering cost-effective, reliable conservation and demand response and distributed and centralized renewable and non-emitting resources to our customers at the lowest reasonable cost. The plan reduces direct PSE emissions and achieves carbon neutrality by 2030 through clean energy investments.

**Near-term Priorities (2024–2029):**

- Add utility scale and distributed resources to achieve renewable or non-emitting energy targets specified in PSE's 2021 CEIP
- Add diverse commercially available resources to meet CETA energy and resource adequacy needs
- Begin commercial activity to acquire bulk transmission to transport renewable energy from distant renewable energy zones to our customers
- Continue to acquire conservation resources
- Continue to develop and refine methods to embed equity into resource decisions
- Lead and actively participate in developing the region's hydrogen hub infrastructure
- Explore commercial opportunities for small modular nuclear capacity and other non-emitting technologies for deployment in the early to mid-2030
- Pursue demand response programs that can effectively help lower peak demand
- Reduce reliance on short-term market purchases in response to the changing western energy market

**Long-term Priorities (2030–2045):**

- Complete acquisition and development of additional transmission capacity (e.g., Cross Cascades, Idaho, Wyoming, Montana, B.C.) to deliver additional clean energy to our customers
- Develop and acquire long-lead generating resources to meet CETA non-emitting generation obligations while maintaining resource adequacy and peak demand
- Explore new capacity options to drive diversity in our energy supply
- Examine repowering or upgrading existing thermal resources and existing renewable generation to better position PSE to achieve the 2045 goal of having an emission-free generation portfolio

## 2.1. Preferred Portfolio

The preferred resource portfolio is a portfolio of resources that can achieve our commitment to reaching CETA goals and achieving carbon neutrality by 2030 and a carbon-free electric energy supply by 2045. Figure 3.1 describes our portfolio of diverse resources; through this combination of conservation, demand response, renewable resources, energy storage and CETA compliant peaking capacity, PSE will reach carbon neutrality by 2030. However, given the large amounts of variable energy resources such as wind and solar, and energy limited resources such as energy storage, we are reliant on newer technologies such as small modular nuclear and hydrogen as a fuel to reach carbon-free energy supply by 2045 while maintaining reliability and resource adequacy.

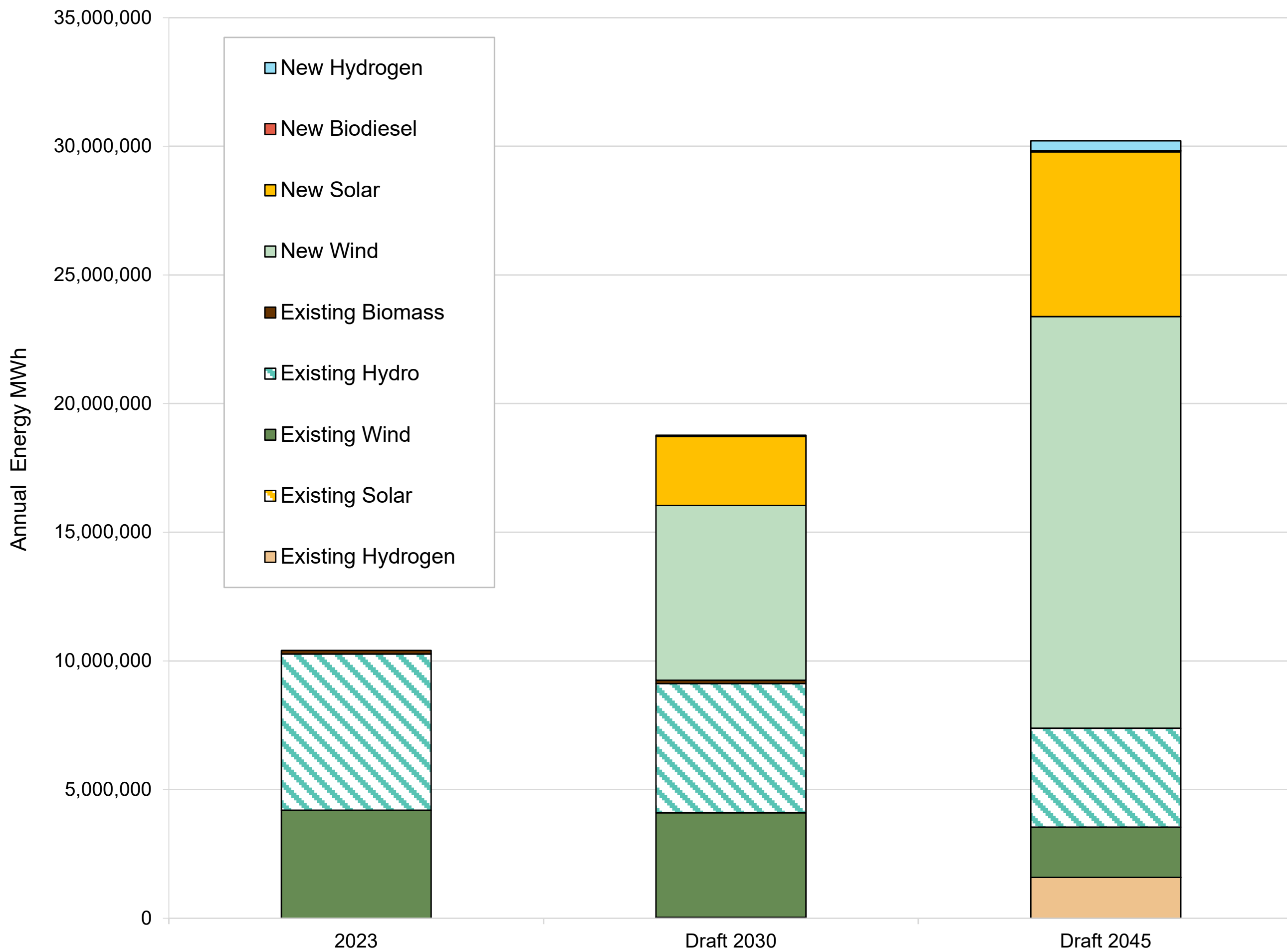
Table 3.1: Electric Preferred Portfolio, Resource Additions Incremental Nameplate Capacity

| Incremental Resource Additions (MW) | 2024-2025 | 2026-2030 | 2031-2045 | Total |
|---|---|---|---|---|
| **Demand Side Resources** | 201 | 417 | 646 | 1,265 |
| Conservation[1] | 65 | 216 | 537 | 818 |
| Demand Response | 136 | 201 | 110 | 446 |
| **Distributed Energy Resources** | 212 | 527 | 1,652 | 2,392 |
| DER Solar[2] | 172 | 380 | 1,572 | 2,124 |
| DER Storage[3] | 40 | 147 | 80 | 267 |
| **Supply Side Resources** | 1,337 | 4,023 | 5,814 | 11,174 |
| CETA Compliant Peaking Capacity | 237 | 474 | 877 | 1,588 |
| Wind | 600 | 800 | 2,250 | 3,650 |
| Solar | 100 | 600 | 1,590 | 2,290 |
| Green Direct | - | 100 | - | 100 |
| Hybrid (Total Nameplate) | 300 | 1,150 | 298 | 1,748 |
| *Hybrid Wind* | 100 | 500 | 200 | 800 |
| *Hybrid Solar* | 100 | 300 | - | 398 |
| *Hybrid Storage* | 100 | 350 | 100 | 550 |
| Biomass | - | - | - | - |
| Nuclear | - | - | - | - |
| Standalone Storage | 100 | 900 | 800 | 1,800 |
| **Total** | 1,750 | 4,967 | 8,112 | 14,830 |

Notes:

1. Conservation in winter peak capacity includes energy efficiency, codes and standards, and distribution efficiency.
2. Distributed Energy Resources (DER) solar includes customer solar photovoltaic (PV), Clean Energy Implementation Plan (CEIP) solar additions, non-wires alternatives, and ground and rooftop solar additions.
3. Distributed Energy Resources (DER) storage includes CEIP storage additions, non-wires alternatives, and distributed storage additions.

Figure 3.1: 100 Percent Clean Energy by 2045




## 2.2. Meeting Future Growth

We will meet future sales growth with the combination of utility-scale resources described and shown in Figure 3.1, demand-side resources (conservation) and distributed energy resources (DERs). Distributed energy resources include storage systems, solar generation, or demand response that provides specific benefits to the transmission and distribution systems and simultaneously supports resource needs. The role of DERs in meeting system needs is changing, and the planning process is evolving to reflect that change. The DERs make lower peak capacity contributions and have higher costs. However, they are essential in balancing utility-scale renewable investments and transmission constraints and meeting local distribution system needs. These resources also provide customer benefits.

In the following section, we detail how the combination of resources in this resource plan will meet demand growth.

## 2.2.1. Conservation

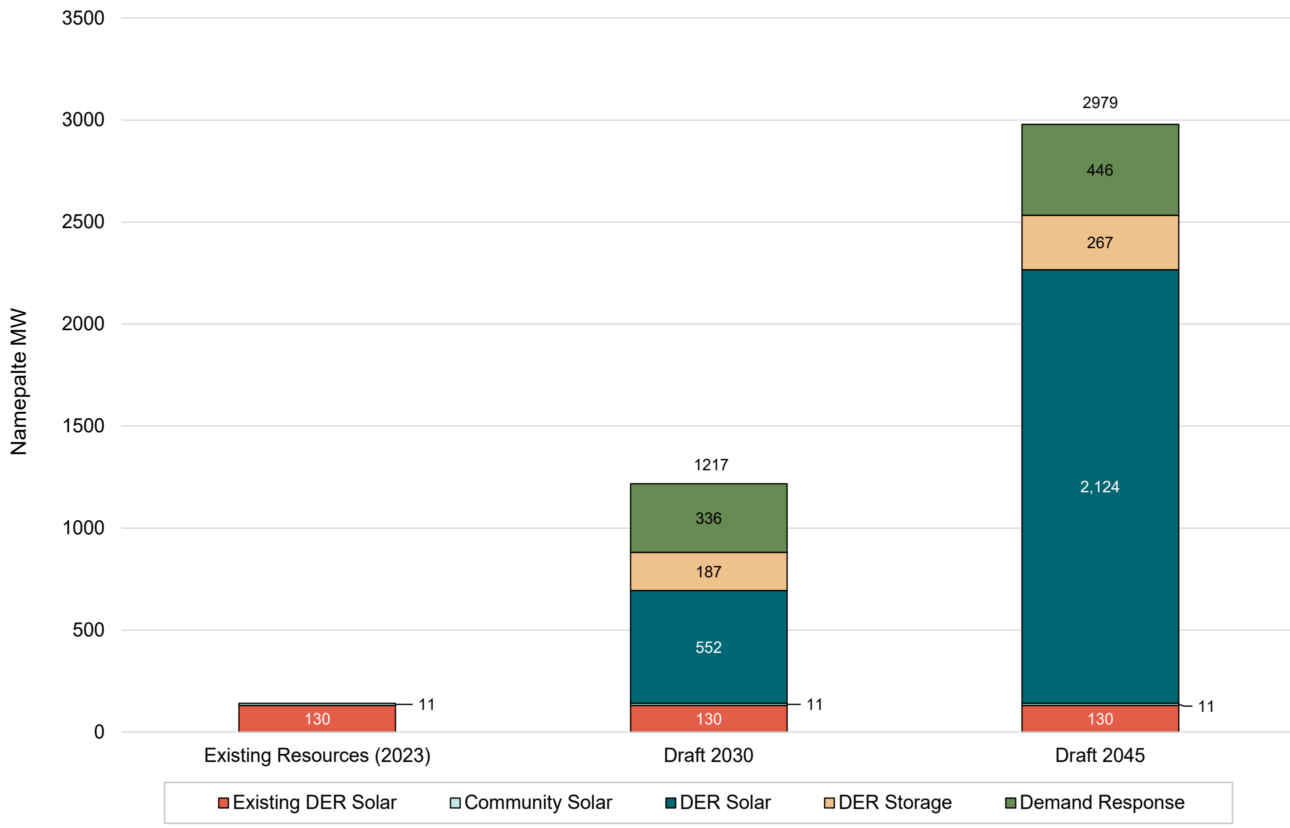
For this analysis, conservation includes new energy efficiency measures, new codes and standards gains in efficiency, and distribution efficiency.

Figure 3.2: New Conservation Savings (MWh)


## 2.2.2. Distributed Energy Resources

Distributed energy resources are any resources located below the substation level. They can be either customer or PSE installed. For this analysis, DERs include demand response and solar and energy storage. Our system currently includes 130 MW of customer-installed rooftop solar and 11 MW of community solar. By 2030, we estimate we will add 552 MW of distributed solar and 187 MW of storage to the portfolio, growing to 2,124 MW of solar and 267 MW of energy storage by 2045. Demand response programs are peak savings options that are offered to customers and can include direct load control for indoor heating and air conditioning thermostats and water heaters and managed electric vehicle charging. Distributed resources cost more than utility scale programs, but are increased from the reference portfolio because they enable larger equity benefits than utility scale resources, described later in the chapter.

Figure 3.3: Distributed Resource Additions (nameplate MW)



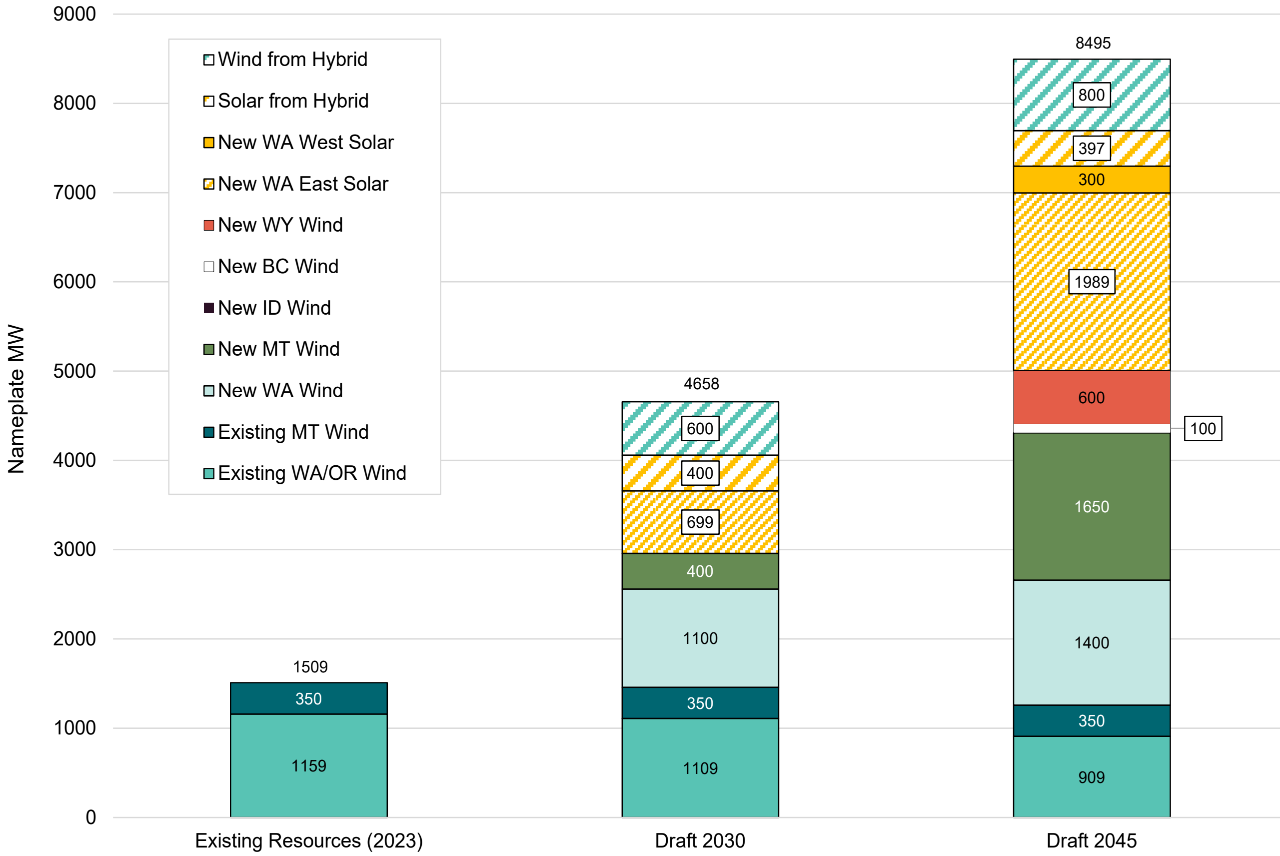

## 2.2.3. Clean Energy Resources

Qualifying clean energy (renewable and non-emitting) resources under CETA include wind, solar, nuclear and alternative fuels such as biodiesel and hydrogen. Along with distributed energy resources, we need to add a significant amount of large utility-scale resources to the portfolio to meet the clean energy requirements.

The scale of renewables needed will require access to renewables outside of Washington State and around the Pacific Northwest region such as Montana, Wyoming, Idaho and British Columbia. We will work to optimize the use of our existing regional transmission portfolio to meet our growing need for renewable resources in the near term. However, the Pacific Northwest transmission system likely will need to be significantly expanded, optimized, and possibly upgraded to keep pace with the growing demand for clean energy. Puget Sound Energy will have to invest in the transmission system to deliver energy to customers from the edge of our territory and support the integration of distributed energy resources and demand response within the delivery grid.

The preferred portfolio adds almost 3,200 MW of new wind and solar resources to meet the CETA clean energy requirements by 2030. Of the 3,200 MW of new wind and solar additions, 2,800 MW are resources located in Washington State that will need to utilize the cross cascades transmission. The remaining 400 MW are in Montana to that will utilize the Montana transmission.

Figure 3.4: Wind and Solar Additions (nameplate MW)



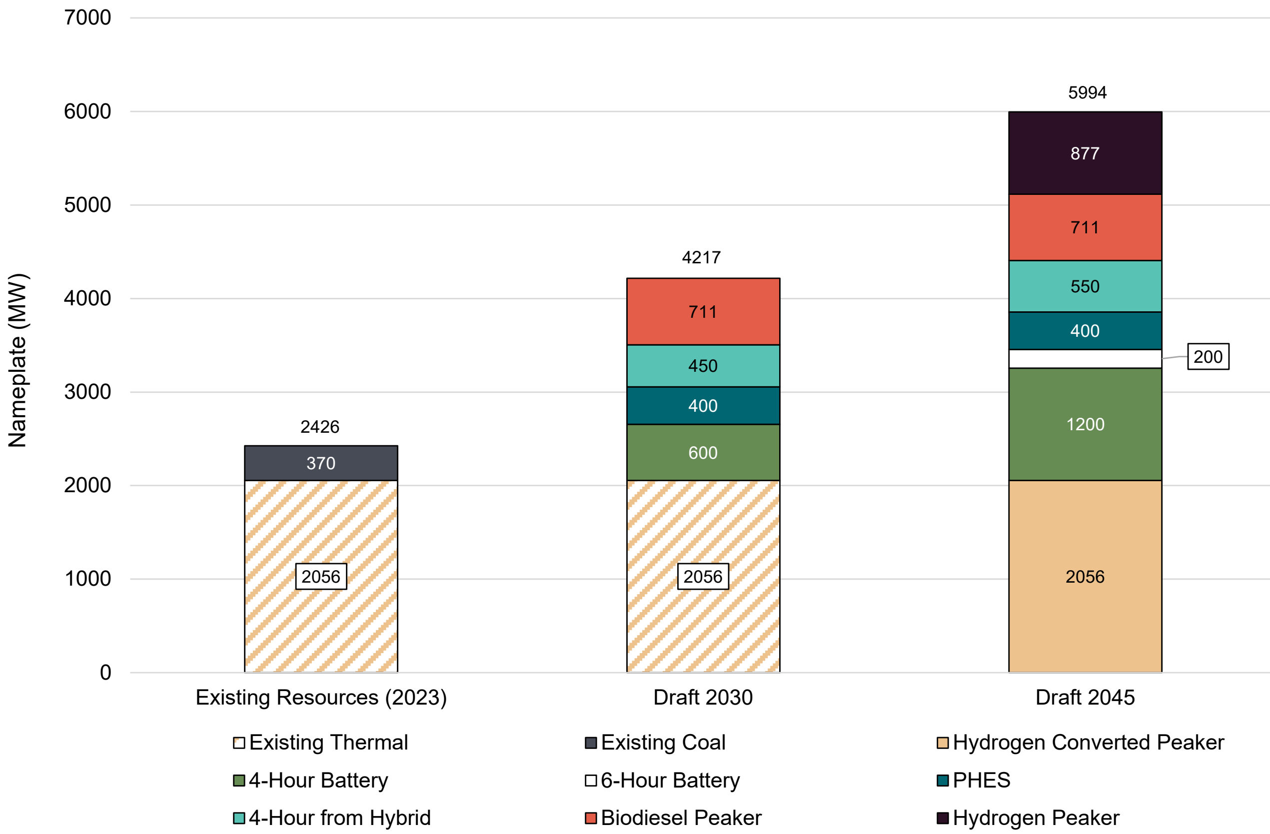

## 2.2.4. Capacity Resources

Qualifying resources under CETA include peaking capacity, energy storage, and nuclear. Peaking capacity modeled includes CETA-qualifying fuels such as biodiesel and hydrogen. Hydrogen fuel is assumed to be available starting in 2030. Natural gas to hydrogen blending is assumed to start at 30 percent hydrogen in 2030 and increase to 100 percent by 2045.

In order to maintain system reliability through resource adequacy, existing thermal resources, which total over 2,000 MW of capacity, remain in the portfolio and are converted to hydrogen. Existing thermal resources were modeled with an option to retire economically or convert to hydrogen starting in 2030. In Figure 3.5 below, three additional peakers are added using biodiesel as a fuel by 2030 and over 800 MW of new hydrogen peakers are added by 2045.

By 2030, 1,450 MW of new energy storage is added and this grows to 2,350 MW by 2045 to help meet resource adequacy and ancillary services. Energy storage resources are not energy producing resources, instead they store the energy produced from other resources so that it is available during peak hours.

Figure 3.5: CETA-qualifying Capacity Additions (nameplate MW)




# 3. Resource Adequacy

The Pacific Northwest electricity industry is transitioning as governments and system planners implement major decarbonization policies. Operators and utilities are retiring significant quantities of coal-fired capacity while adding new renewable generation resources. As a result, PSE and other utilities are rethinking how we plan our systems, especially concerning resource adequacy. As we transition to 100 percent clean energy by 2045, adequate resources are paramount. We must ensure that customers receive reliable electricity and experience a smooth transition to a decarbonized system. The resource adequacy analysis for this 2023 progress report has led to an increase in the planning reserve margin to 23.8 percent in 2029, a deficit of 2,629 MW from the 2021 IRP. Several elements contributed to the rise in the planning reserve margin and capacity deficit:

- Inclusion of climate change data in the load forecast and peak temperatures — when we accounted for average temperature trends it only slightly lowered the 1-in-2 winter peak and increased the summer peak. Despite the increase in summer peak temperatures, it does not come close to the winter peak level in this report's planning horizon. However, we saw an increase in volatility of temperatures which was accounted for in the resource adequacy and contributed to the overall increase in the planning reserve margin.

- Increase in peak demand — although the 1-in-2 winter peak lowered slightly, the updated electric vehicle (EV) forecast increased the demand. The increase in peak from the EV forecast was larger than the decrease from the climate change data, resulting in an overall increase to the 1-in-2 peak demand.

Climate change data also showed changes in the duration and frequency of loss of load events, which impacted the results. The data showed a decrease in event duration, less frequent events in the winter and more frequent events in the summer. Thus, increasing the effective load carrying capacity (ELCC) for shorter duration storage resources and solar.

Incorporating climate change in the modeling changed the hydroelectric generation profile. The climate change data showed the historical spring runoff is happening earlier in the year, changing hydropower availability. Thus, changing the generation profile of hydroelectric generation and leaving less water for the summer.

# 3.1. Reducing Market Reliance

Although the western energy market has had surplus capacity for more than a decade, PSE's available firm transmission to the Mid-Columbia market hub has been a cost-effective way to meet demand by purchasing energy supply from the regional power market. However, the supply and demand fundamentals of the wholesale electric market have changed significantly in recent years in two important ways: tightening supply and increasing pricing volatility.

In response to these changing conditions, we plan to replace those short-term market supplies with firm resource adequacy qualifying capacity contracts compliant with CETA that meet our resource adequacy requirements and align with a potential regional resource adequacy program. The peak capacity resource need and the preferred portfolio in this report reflect added firm capacity resources while reducing the number of short-term market purchases.

Our approach allows us to survey the market for available resource adequacy qualifying agreements, and it allows for the development of the regional resource adequacy program requirements, which will help inform PSE's future needs. Given the tightening of energy markets and to prepare for possible participation in the Western Resource Adequacy Program (WRAP), PSE is planning to reduce its reliance on short-term wholesale market purchases

We recognize this approach has challenges, including permitting and building generating and storage resources and transmission to meet growing demands in an increasingly complex permitting landscape. Although those challenges are real, we are confident the resource plan in this 2023 Electric Report puts us on a path to reach our clean energy goals and achieve the clean energy future our customers expect.

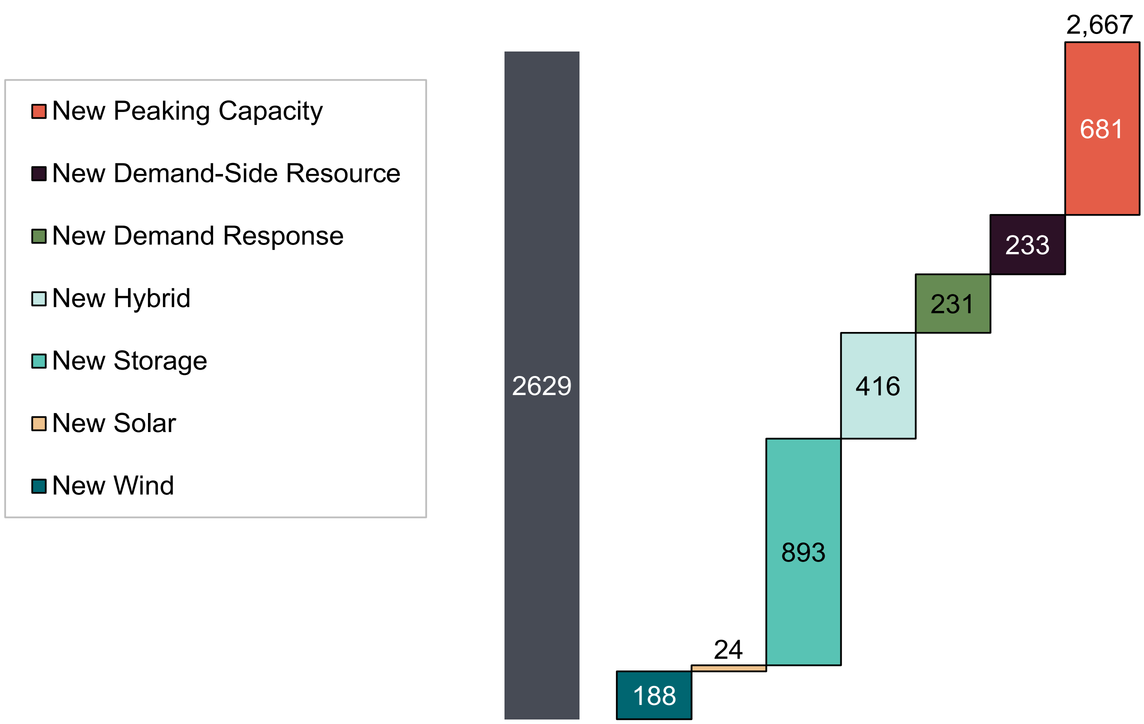
# 3.2. Winter Peak Driving Resource Capacity Additions

Even though we analyzed summer and winter peak capacity, the winter peak is higher than the summer peak. With the increase of renewable energy and energy storage in the portfolio, those resources contribute to the summer peak need better than they contribute to the winter. For example, solar has a four percent peak capacity contribution in the winter but a 55 percent contribution in the summer. We added solar to the portfolio because it meets the CETA requirement and the summer peak need, but it does very little to meet the winter peak need.

After meeting CETA and the summer peak, this leaves the winter peak short, so we need new peaking capacity to maintain resource adequacy for the winter. The winter peak capacity deficit is 2,626 MW, and we added 2,667 MW peak capacity to the portfolio. The summer peak deficit is 2,770 MW, and we added 3,025 MW peak capacity. The summer peak deficit is higher than the winter deficit because fewer resources are available in the summer than in the winter. However, the total winter peak is still higher than the summer.

This approach balances the winter peak and creates a summer peak surplus of more than 254 MW. Figure 3.6 shows the breakdown of the winter peak capacity contribution for new resources.

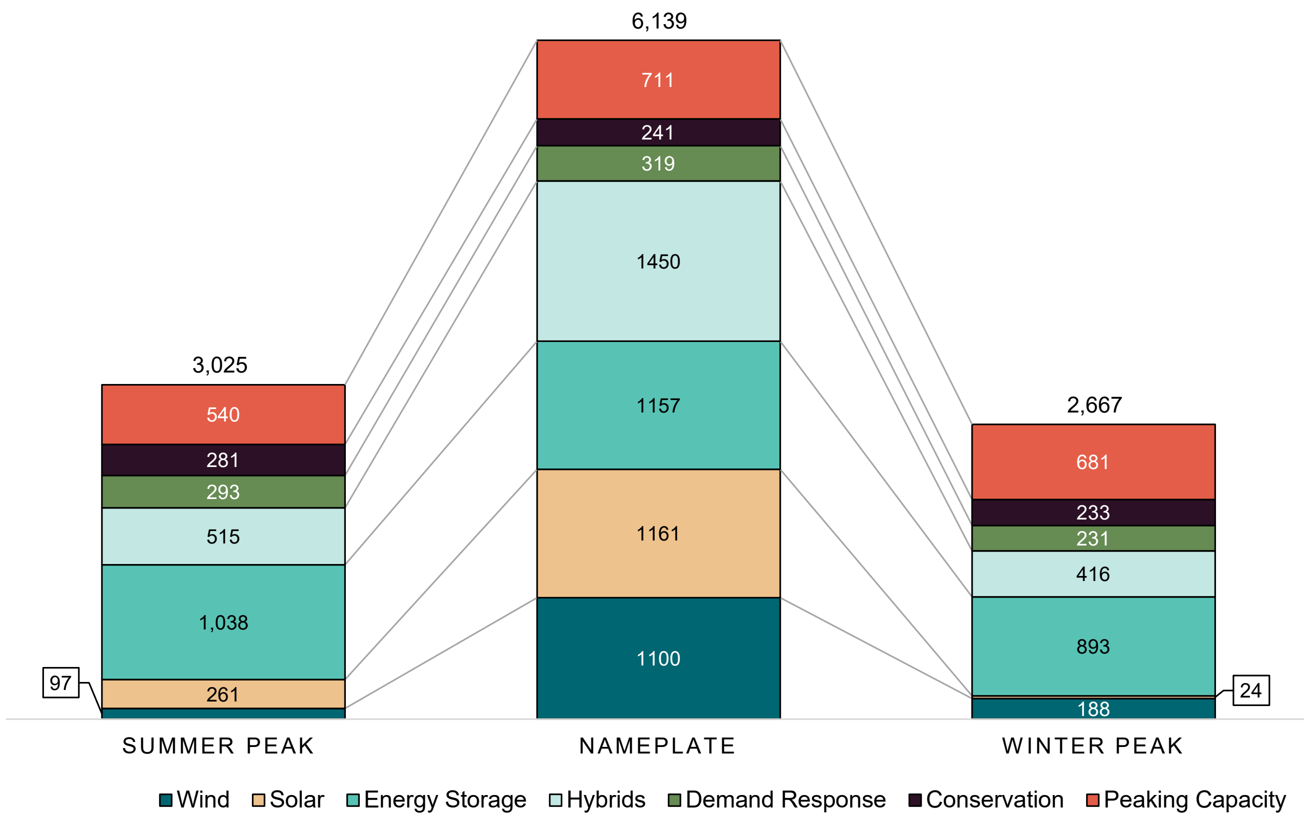
Figure 3.6: Meeting Winter Peak Need for 2029 (peak capacity MW)




## 3.3. Nameplate versus Peak Capacity

Because of the peak capacity contribution of each resource, we need more resources to meet the peak need. For example, solar's 24 MW peak capacity contribution requires over 1100 MW of installed nameplate capacity. After adjusting for peak capacity contribution, 6,139 MW of installed nameplate capacity on new resources adjusts to 3,025 MW summer peak capacity and 2,667 MW winter peak capacity, as detailed in Figure 3.7.

Figure 3.7: Nameplate Capacity Adjusted to Peak Capacity Contributions (MW)




# 3.4. Benefits of a Diverse Portfolio

As PSE and the region seek to decarbonize systems, the future of electricity is a diverse portfolio of non-emitting resources. A diverse energy mix is critical for energy security because it is less dependent on a single fuel source, reducing vulnerabilities due to market price, supply fluctuations, and political unrest. Multiple, reliable generation sources allow a utility to continue to provide power without disruption if one energy source fails. A diverse portfolio also reduces environmental impacts, improves reliability, and promotes innovation to meet the needs of PSE's more than 1.5 million customers. Maintaining resource diversity is the key to reducing emissions while preserving reliability and affordability.

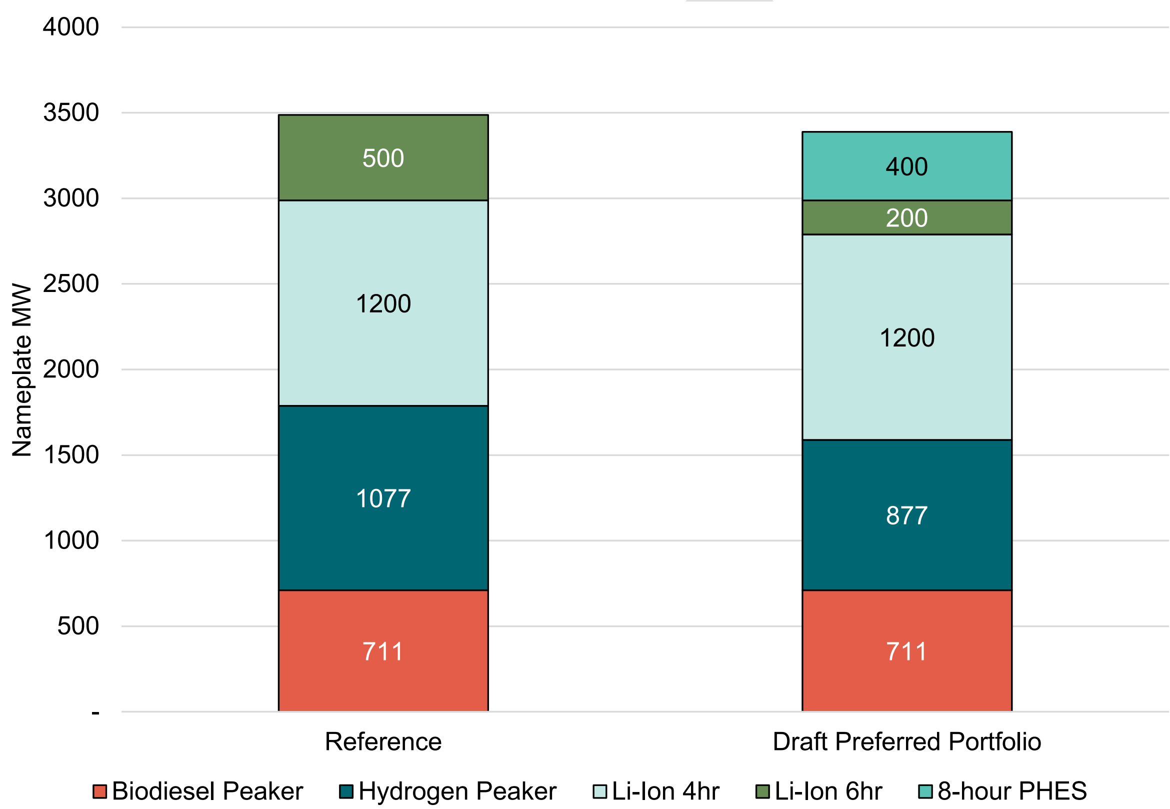
The least-cost reference portfolio relies primarily on a few resources because the model is designed to select the lowest-cost resources available. However, we need to consider factors such as risk and feasibility when considering resources to include in the preferred portfolio. For example, the least-cost reference portfolio relies heavily on 4-hour batteries because it is the lowest cost energy storage resource and hydrogen as a fuel. Hydrogen is the lowest cost, CETA-compliant fuel source for thermal resources. To develop the preferred portfolio, we adjusted away from the least-cost reference portfolio to bring more diversity and lower the technology and feasibility risks inherent in the least-cost reference portfolio.

The adjustment includes adding 400 MW of pumped hydro energy storage into the mix in 2026 plus 400 MW of Montana wind to diversify from the 1700 MW of battery energy storage.

Another possible adjustment that was tested, but not included in the preferred portfolio includes adding advanced nuclear small modular reactor (SMR) in 2032 to diversify from 2,800 (existing and new) MW of hydrogen-fueled thermal plants.

Figure 3.8 below shows how we adjusted the portfolio from the reference case to create a diverse portfolio that relies on multiple resources to meet demand.

Figure 3.8: Nameplate Additions by 2045 (MW)




**Energy Storage:** The least-cost reference portfolio adds 1,000 MW of 4-hour batteries by 2030 because they are the lowest-cost energy storage resources. We adjusted the types of energy storage resources for the preferred portfolio to include more diverse technologies. For the preferred portfolio, we added 200 MW of pumped hydroelectric energy storage (PHES) in Montana and 400 MW of new Montana wind along with the existing 350 MW of wind. An additional 200 MW of PHES located in the Pacific Northwest is also added to the preferred portfolio for a total of 400 MW of PHES. The remaining energy storage is then a mix of 4-hour and 6-hour batteries.

**Advanced Nuclear (SMR):** In the least-cost reference portfolio, we modeled building over 800 MW of new hydrogen peakers by 2045 on top of the 2,000 MW of existing resources converted from natural gas to hydrogen. By 2045, we projected hydrogen to account for 36 percent of the peak capacity contribution. This least-cost reference portfolio relies heavily on a single fuel source with an unknown supply, creating risk. As a way to diversity the portfolio, we can explore other technologies such as small modular nuclear for inclusion in the preferred portfolio in the future. There are many unknowns around new advanced nuclear technology. While the high cost of nuclear deterred us from including it in the preferred portfolio at this time, we will continue to monitor the maturity of the technology as a resource to help reduce the risks of relying on only a few technologies and a way to meet the CETA 100 percent requirement by 2045. In the future, we believe nuclear resources will be essential for diversifying our dispatchable generating resources, hedging against over-reliance on alternative fuels including hydrogen and biodiesel and ensuring we can meet peak capacity needs. Nuclear also provides a firm source of clean energy to the portfolio, whereas energy storage does not produce energy and is dependent on oversupply in the market.

# 4. Developing the Plan

We first developed a least-cost reference portfolio using the AURORA model's capacity expansion function. This portfolio did not address that the future of power is a diversified portfolio of non-emitting resources providing energy security and reliability for all customers. There is no single perfect answer or resource that will solve all our energy needs. That is why a diversified portfolio is critical, including a mix of utility-scale and distributed energy resources and a blend of intermittent, energy-limited, and firm-capacity resources. These are essential components when determining the portfolio mix.

## 4.1. Our Clean Energy Future

Puget Sound Energy has been an early leader in addressing climate change, investing billions in renewable resources and energy efficiency for homes and businesses. Now, we are on a path to meet our customers' current and future needs and reach Washington State's ambitious clean energy transformation policies and PSE's aspirational goals.

Under our proposed 2021 Clean Energy Implementation Plan, we will increase the amount of clean energy in our portfolio by 2025 as part of our progress toward meeting Washington State's 80 percent clean electricity by 2030 policy. As we work to create a new clean energy future and address climate change, we must do so in a way that ensures all our customers, especially historically marginalized communities, have a voice in and benefit from the transition to clean energy. We are applying an equity lens in this plan. We know that we cannot do this work alone. Therefore, we are partnering with our customers, communities, and others to build plans to address all our customers' needs while meeting key milestones.

Puget Sound Energy has served customers and communities across Washington State for nearly 150 years. We are committed to providing clean, safe, reliable, affordable, and equitable energy. With our commitment in mind and consulting with interested parties, we developed candidate portfolios that would better enable equity-enhancing resources and diversify technology risk.

# 4.2. Summary of Candidate Diverse Portfolios

The first step to developing a preferred portfolio is to start with a least-cost portfolio. A least-cost portfolio meets all the constraints in the lowest-cost way. These constraints are:

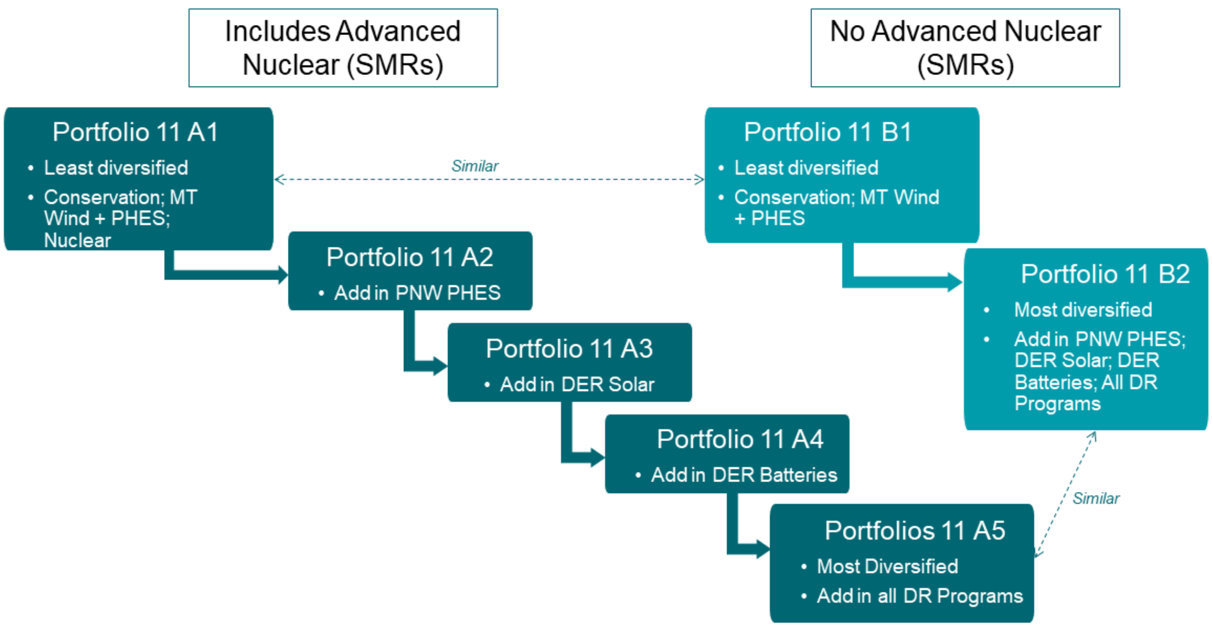
- Peak capacity plus planning margin
- Hourly customer demand for the year
- CETA renewable and clean-energy requirements
- Reduced market reliance at peak
- Transmission access for new resources

The least-cost portfolio gave us a starting point which we then adjusted to identify a feasible portfolio of diverse resources that consider equity and create customer benefits while maintaining reliability and affordability. We refined the least-cost portfolio with an eye towards maximizing benefits and reducing burdens to vulnerable populations and highly impacted communities consistent with CETA. Figure 3.9 shows a progression of diversified portfolios ranging from the least diverse portfolio 11 A1 to the most diverse portfolio 11 A5, with each step in-between adding an additional scheduled resource addition to increase the portfolio's diversity. Portfolios 11 B1 and 11 B2 were modeled at the request of interested parties and represent the least and most diversified portfolios (11 A1 and 11 A5) excluding advanced nuclear SMR additions.

To create a diverse portfolio, we:

1. Start with the least cost reference portfolio
2. Make incremental changes to the portfolio to test the sensitivity of the adjustment to resource builds and portfolio cost
3. Create a portfolio with different options from part 2, considering equity, cost, feasibility, reliability, and diversity of energy supply

Figure 3.9: Components of the Diverse Portfolios

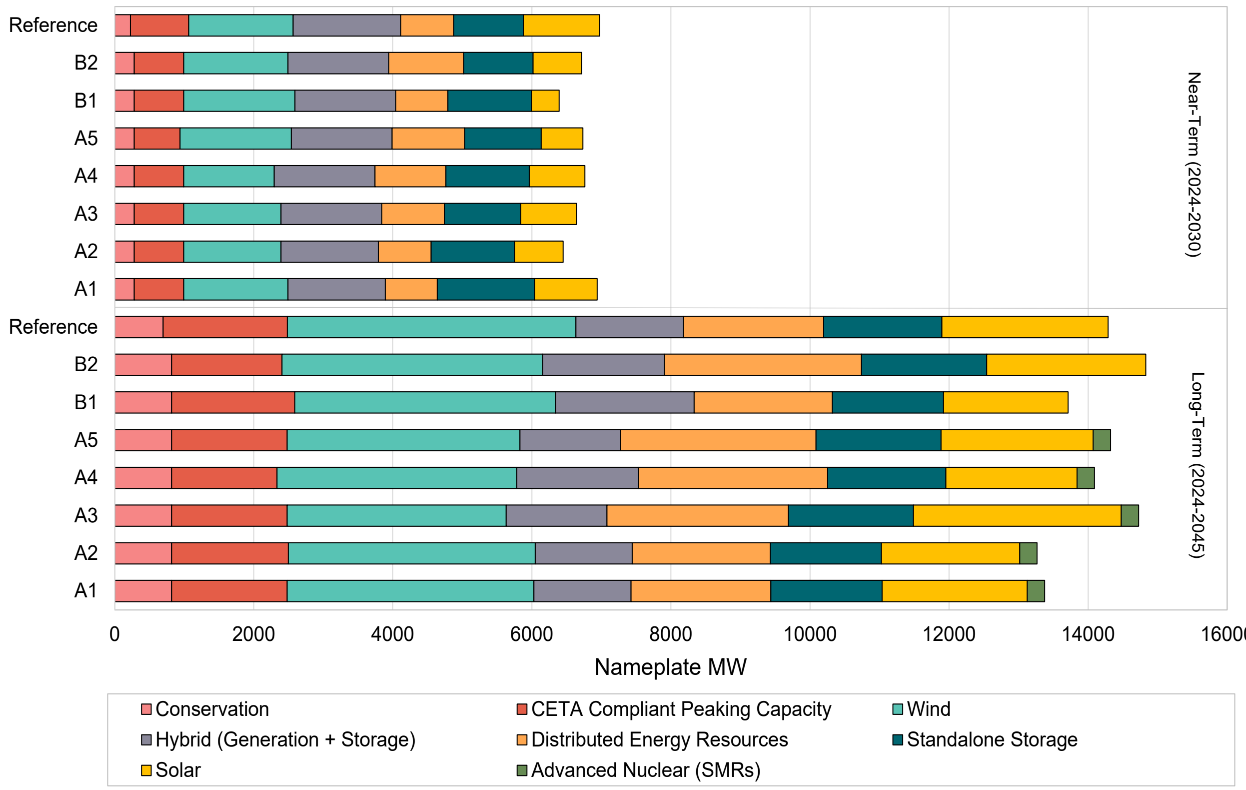



Portfolios 11 A5 and B2 are the most diverse portfolios and focus on increasing distributed resources such as energy storage, solar, conservation, and demand response.

Portfolios 11 A1, A2 and B1 are less diverse to increment in different changes starting with conservation increases and utility-scale resources.

We tested these portfolios to see how they enabled equitable outcomes for customers (see Section 4.3: Portfolio Benefit Analysis) and to determine the increased costs relative to the reference scenario. Figure 3.10 shows a breakdown of resource additions by portfolio. In the near term (2024 – 2030), the portfolios are very similar. PSE has a large need for resources to meet CETA and resource adequacy and there is a limited number of technologies that are commercially available and able to be constructed today. All the diverse portfolios have equal amounts of conservation and CETA-compliant peaking capacity, with the rest of the resources comprising demand response, wind, solar, energy storage, or a hybrid of renewable resources plus energy storage. For the longer term (2031 – 2045) the resource mix becomes more pronounced between portfolios though the need for conservation and CETA-compliant peaking capacity is a stable addition across all portfolios.

Figure 3.10: Resource Builds (Nameplate MW)




# 4.3. Portfolio Benefit Analysis

The Clean Energy Transformation Act requires utilities to consider equity and ensure all customers benefit from the transition to clean energy. However, AURORA, a traditional production cost model that we use for portfolio modeling, only solves for the least-cost solution. Therefore, we developed and used a portfolio benefit analysis tool to support our understanding of equity-related benefits and the associated costs within each portfolio, and inform our work as we strive to select a portfolio best suited to enable equitable outcomes for customers while also considering cost. The preferred portfolio provides the best pathway to improve equitable outcomes of all the portfolios we evaluated in this report. This outcome was driven primarily by increasing customer opportunities to participate in distributed energy and demand response programs.

The portfolio benefit analysis tool measures potential equity-related benefits to customers within a given portfolio and the tradeoff between those benefits and overall cost. We evaluated these benefits using quantitative customer benefit indicators (CBIs) and their metrics. Customer Benefit Indicators are quantitative and qualitative attributes we developed for the 2021 CEIP in collaboration with our Equity Advisory Group (EAG) and interested parties. These CBIs represent some of the focus areas in CETA related to equity, including energy and non-energy benefits, resiliency, environment, and public health.

For this report, we evaluated each portfolio using a subset of the CBIs proposed in the 2021 Clean Energy Implementation Plan, which as of this date is still pending Washington Utilities and Transportation Commission (Commission) approval. The subset of CBIs was selected based on whether the AURORA modeling tool could quantitatively evaluate them, i.e., AURORA already had a comparable metric. The CBIs we included in the portfolio benefit analysis are:

- **Improved access to reliable, clean energy** — measured by customers with access to distributed storage resources
- **Improved affordability of clean energy** — measured by the total portfolio cost
- **Improved outdoor air quality** — measured by sulfur oxides, nitrogen oxides, and particulate matter generated per portfolio
- **Increase the number of jobs** — measured by the number of estimated jobs generated for each portfolio
- **Increases participation in Energy Efficiency, Distributed Energy Resource, and Demand Response Programs** — measured by energy efficiency capacity added and the number of customers projected to participate in distributed energy resources and demand response programs
- **Reduced greenhouse gas emissions** — measured by the total amount of $CO_2$-eq[1] generated per portfolio
- **Reduced peak demand** — measured by the decrease in peak demand achieved via demand response programs

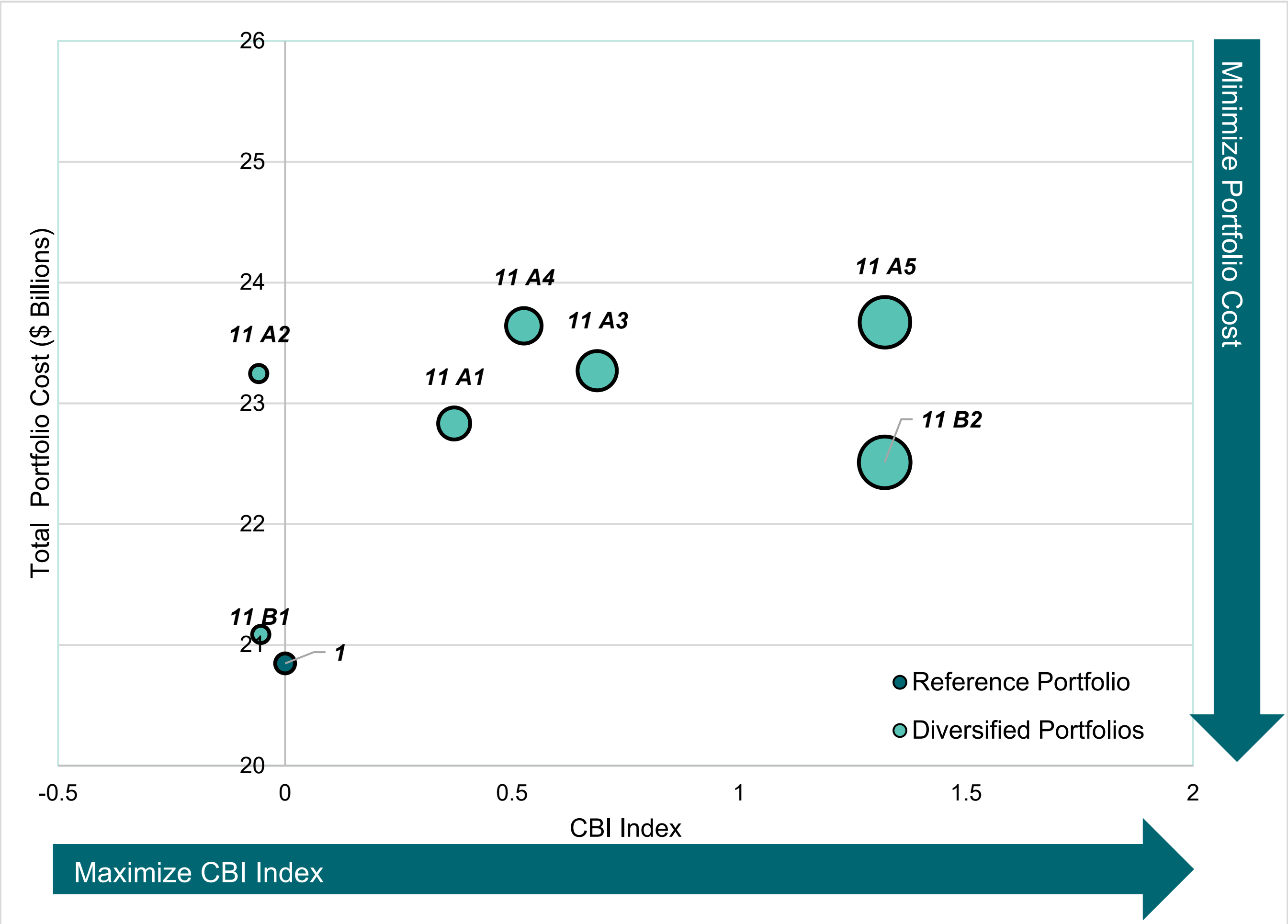
The portfolio benefit analysis generates a CBI index for each portfolio, an aggregate measure of these CBIs (sans the portfolio cost) normalized to the reference, least-cost portfolio. A higher CBI index indicates that a portfolio enables more equity-related benefits than the reference portfolio. The CBI index juxtaposes each portfolio's total cost (direct costs plus externality costs). The plot (Figure 3.11) illustrates the tradeoff between increasing portfolio benefits and the associated metrics and costs. Compared to the reference portfolio, the most efficient portfolios have the highest CBI indices with minimal increase in portfolio cost and sit closest to the bottom right corner of the plot.

Figure 3.11 shows the results generated by the portfolio benefit analysis tool for all diversified portfolios analyzed in this report. We can see that portfolio 11 B2 is the most efficient of the diversified portfolios because it lies furthest to the right with the highest CBI index. Which is one of the reasons portfolio 11 B2 was selected as the preferred portfolio. It has the highest overall CBI index at 1.32 and is the most diversified portfolio without nuclear that we evaluated in the 2023 Electric Report.



1 $CO_2$-eq or $CO_2$-equivelant is a measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP). Using the GWP, other greenhouse gases are converted to the equivalent amount of carbon dioxide.

Figure 3.11: Portfolio Benefit Analysis Tool Results




The high CBI index of portfolio 11 B2 comes from improvements in all CBIs considered in this analysis except for jobs, which varied only slightly from the reference portfolio by less than half a standard deviation (index = -0.41). The benefits in the preferred portfolio include some of the highest potential customer participation numbers for DER solar, DER storage, and demand response programs at 87,492, 18,524, and 750,943 participants, respectively. The preferred portfolio also reduces greenhouse gas and other harmful emissions in comparison to the reference portfolio (Table 3.2).

Table 3.2: Portfolio CBI Metrics

| CBI Metric | 1 Reference | 11 A5 Diversified Portfolio | 11 B2 Diversified Portfolio |
|---|---|---|---|
| Cost ($, Billions) | 20.85 | 23.67 | 22.51 |
| GHG Emissions (Short Tons) | 48,824,734 | 41,543,008 | 44,372,601 |
| $SO_2$ Emissions (Short Tons) | 28,841 | 28,836 | 28,759 |
| $NO_x$ Emissions (Short Tons) | 11,426 | 10,307 | 10,805 |

| CBI Metric | 1 Reference | 11 A5 Diversified Portfolio | 11 B2 Diversified Portfolio |
|---|---|---|---|
| PM Emissions (Short Tons) | 9,036 | 8,873 | 8,940 |
| Jobs (Total) | 45,736 | 40,757 | 43,795 |
| Energy Efficiency Added (MW) | 695 | 818 | 818 |
| DR Peak Capacity (MW) | 291 | 320 | 320 |
| DER Solar Participation (Total New Participants) | 12,115 | 83,903 | 87,492 |
| DR Participation (Total New Participants) | 513,238 | 750,943 | 750,943 |
| DER Storage Participation (Total New Participants) | 8,125 | 18,524 | 18,524 |

The results of the portfolio benefit analysis indicate that increasing distributed and demand-side resources significantly increase the potential for more equitable outcomes for customers. In comparison to the reference portfolio, the preferred portfolio has the following additions:

- **Conservation**: increases to 371 MW by 2045, an increase of 113 MW above the least-cost conservation.
- **Demand Response**: increases to 446 MW by 2045, an increase of 41 MW above the least-cost portfolio.
- **Distributed solar**: added 30 MW per year from 2026–2045, a total of 630 MW added by 2045 above the least cost portfolio.
- **Distributed storage**: added 25 MW per year from 2026–2031, a total of 150 MW added distributed storage above the least cost portfolio.

The preferred portfolio achieved the highest CBI index of all portfolios evaluated in this 2023 Electric Report. In pursuing the preferred portfolio, we will adopt a pathway forward for acquiring the resources necessary for a more equitable distribution of customer energy and non-energy burdens and benefits.

## 4.4. Portfolio Costs

The portfolio costs include all costs associated with construction, interconnection, transmission, fuel, and operations and maintenance of new generating resources along with the costs to operating and maintain existing resources. We divided the portfolio costs into near-term resource additions before 2030 and longer-term, 21-year decisions for 2045. Adding additional distributed resources to the portfolio increases the equity metrics we used, but it also increases the cost of the portfolio. Figure 3.12 shows the annual portfolio costs for 2024–2029, and Table 3.3 shows the six-year net present value (NPV) of direct costs and the social cost of greenhouse gases (SCGHG).

Figure 3.12: Annual Portfolio Costs with Emissions 2024–2029 (billions of dollars)

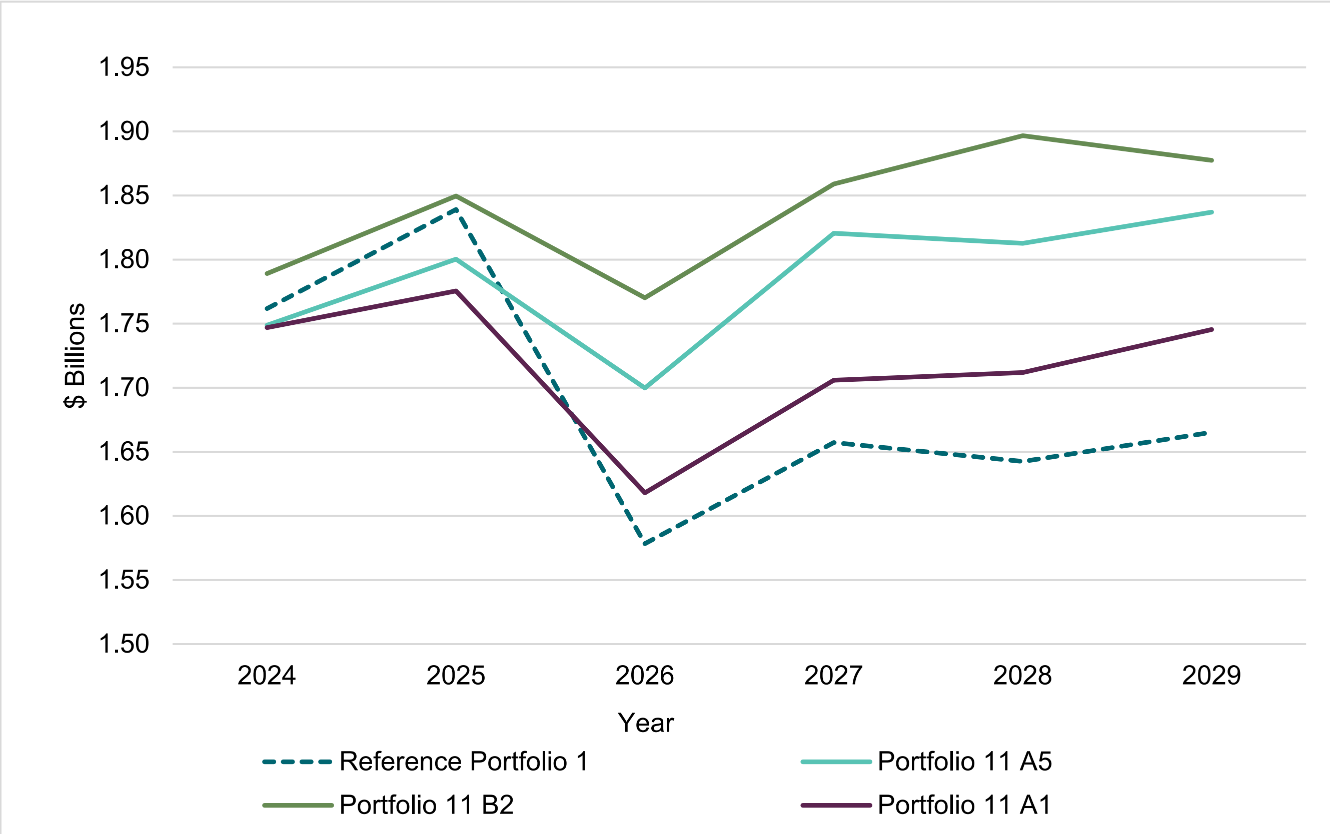



Table 3.3: Six-year NPV 2024–2029

| Six-year NPV (2024–2029) (Billions of Dollars) | Reference Portfolio 1 | Portfolio 11 A5 | Portfolio 11 A1 | Portfolio 11 B2 |
|---|---|---|---|---|
| Portfolio Cost with SCGHG | 8.14 | 8.55 | 8.24 | 8.81 |
| Portfolio Cost without SCGHG | 6.05 | 6.75 | 6.49 | 6.93 |
| Social Cost of Greenhouse Gases (SCGHG) | 2.08 | 1.80 | 1.75 | 1.88 |

The combination of increases in distributed resources, conservation, demand response, and diversifying the portfolio delays adding one peaking generation facility until after 2030 but increases the cost over the reference case by $700 - $880 million over the next six years.

# 4.5. Resource Plan Additions

Puget Sound Energy is committed to reaching CETA goals and achieving carbon neutrality by 2030 and a carbon-free electric energy supply by 2045. The electric resource plan reflects our path to meeting our CETA commitments. Our plan prioritizes delivering cost-effective, reliable conservation and demand response and distributed and centralized renewable and non-emitting resources to our customers at the lowest reasonable cost. The plan reduces direct PSE emissions and achieves carbon neutrality by 2030 through clean energy investments and projected alternative compliance options. The resources behind the plan can be divided into near-term and longer-term resources.

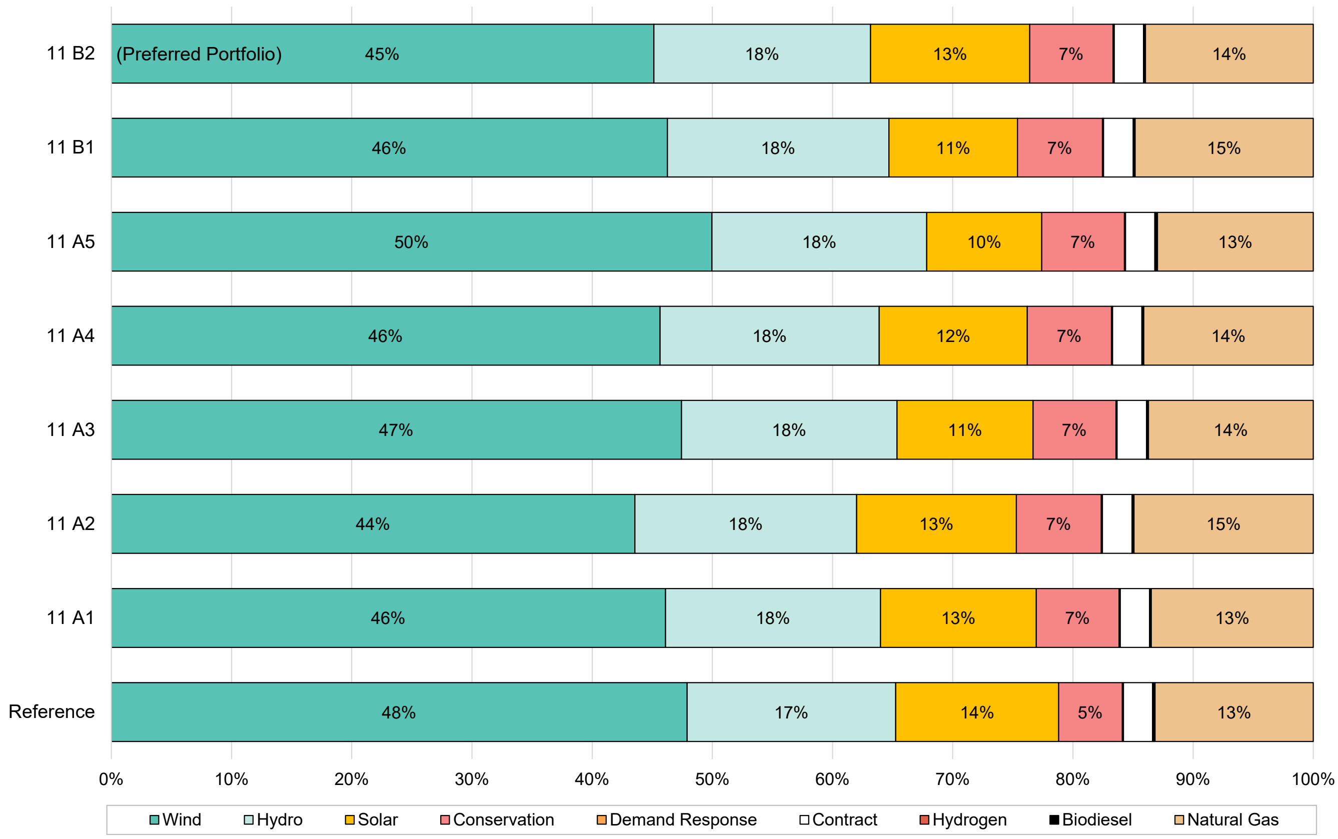
**Near-Term Resources (2024–2029)**

The utility scale and demand-side resources builds in the near term are similar across the diversified portfolios. In all the diversified portfolios, we need three peaking generation facilities by 2030 in order to maintain reliability as new variable resources are added. By 2030, almost 1,500 MW of new energy storage is added to help meet resource adequacy and ancillary services. Energy storage resources are not energy producing resources, they just store the energy produced from other resources so that it is available during peak hours. Given that over 3,000 MW of variable energy resources are added by 2030 to meet the CETA requirements, the energy storage resources will be needed to help store energy in low demand hours to be used later in high demand hours.

The difference between the portfolios is the amount of distributed energy resources added to the portfolio. We listened to interested parties and PSE's Equity Advisory Group (EAG) and heard the importance to add more distributed resources to the portfolio and increase customer participation in these programs. The preferred portfolio increases DER programs and has the highest CBI index. However, this comes at a higher cost as well.

No matter which portfolio is used for the preferred portfolio, the near-term resources are the same for utility scale resources, we need to meet CETA requirements and resource adequacy, and there are limited options available to achieve these needs in the next six years. Portfolio 11 B2 was chosen as the preferred portfolio because it enables the most equity-related benefits of all the portfolios we evaluated in this report. This outcome was driven primarily by increasing customer opportunities to participate in distributed energy and demand response programs.

Figure 3.13: Annual Energy 2030 – by Fuel Type (percent of generation)




**Long-Term Resources (2030–2045)**

As we look further into the future, the resources become less certain. We know that technological advancements are needed in order to achieve 100 percent clean energy by 2045. This could be through alternative fuels used in combustion turbines such as hydrogen or through new small modular nuclear technology. Both options are promising but present their own unique risks and costs. We will continue to explore these and other resource options in the next and future IRP cycles.

Regardless of what technologies may be available in the long-term, it does not change the near-term resources and resource options. We are confident this preferred portfolio keeps us on a path to meeting the CETA 2030 requirements.

Figure 3.14: Annual Energy 2045 – by Fuel Type (percent of generation)