2021 PSE Integrated Resource Plan

2 Clean Energy Action Plan

This chapter describes the 10-year Clean Energy Action Plan for implementing the Clean Energy Transformation Standards.

Contents

1. OVERVIEW

The Clean Energy Action Plan (CEAP) provides a 10-year outlook, refining the IRP resource plan. Per RCW 19.405.060, the Clean Energy Implementation Plan (CEIP) will be informed by the CEAP in developing a plan for specific targets, interim targets and specific actions over a 4-year period. The CEIP will prescribe the target resources, programs, and enabling systems aligned with the IRP/CEAP.

The content of the CEAP is specifically defined as per WAC 480-100-620 Section 12 of the final proposed rules for the IRP and CEIP Rulemaking Dockets UE-191023 and UE-190698. At the time of this draft, some topics remain unresolved and the rules are not yet in effect. The Clean Energy Transformation Act (CETA) introduced the CEAP as a new aspect of the IRP to identify likely action over the next 10 years. This is the first IRP that includes the draft CEAP. As PSE gains clearer understanding and stakeholder feedback for the CEAP, PSE will refine the CEAP in time for the April 1, 2021 final IRP. As with any new requirement or assessment, the CEAP will evolve over time, and future IRPs will benefit from the lessons learned in this first implementation of the new planning process. PSE looks forward to stakeholder feedback on this draft CEAP.

2. EQUITABLE TRANSITION TO CLEAN ENERGY

Assessment of Current Conditions

CETA sets out important new planning standards that require utility resource plans to ensure that all customers benefit from the transition to clean energy. To achieve this goal, an Economic, Health and Environmental Benefits Assessment is performed to provide guidance in the development of the utility's CEAP and CEIP. The purpose of the assessment is two-fold: first, to identify and quantify to the extent possible the existing conditions for all customers, and second, to identify disparate impacts to communities within and around PSE's service territory that are affected by resource planning. By incorporating the assessment, the utility can propose actions and programs that are not simply lowest reasonable cost, but also distribute benefits equitably among customers.

The assessment will identify specific metrics and be informed by the cumulative impact analysis from the Washington State Department of Health. The Washington State Department of Health anticipates completing the cumulative impact analysis by the end of December 2020; the results of that study will be reported in the final 2021 IRP filing.

While the cumulative impact analysis is not complete, PSE has worked to incorporate existing information into the assessment for this IRP. PSE presented this information at the November 2020 IRP meeting and solicited stakeholder feedback through a series of questions designed to inform the assessment, and this feedback has been incorporated. Based on the feedback received and the availability of the cumulative impact assessment from the Department of Health, PSE will develop initial set of metrics to quantify existing conditions observed across PSE's customers in order to evaluate disparities between populations within the customer base. The assessment will be available in the final IRP.

PSE recognizes the importance of developing a process where all voices are included and heard and acknowledges that the IRP public participation process is the first incremental step in stakeholder feedback on the assessment. Many populations and communities are not represented in the IRP public participation process. This is an important part of the evolution of the utility planning process, and PSE anticipates additional engagement through the CEIP process, as well as in future IRP cycles.

Role of the Equity Advisory Group

PSE will establish an Equity Advisory Group to provide specific input on the first CEIP, due in 2021, as well as the implementation of that plan. In future planning cycles, the input of the Equity Advisory Group will be important to incorporate starting with the planning for the IRP process. This will be an important area of learning and improvement through the entire planning cycle from IRP through to the CEIP. For this IRP, due to the timing of the rulemaking and establishment of the Equity Advisory Group, PSE will incorporate feedback as much as possible without the Equity Advisory Group in place yet.

Developing Customer Benefit Indicators

An assessment of current conditions must be completed before customer benefit indicators are developed. The assessment informs the development of the CEAP and the CEIP. Under the draft rules, indicators are specifically developed during the CEIP. Feedback on indicators for this first planning cycle under CETA will be captured through the CEIP. The initial qualitative and quantitative metrics developed through the assessment give a snapshot in time of specific measures related to economic, health, environmental, and energy security and resiliency impacts. Indicators will be evaluated over time to measure progress tied to an attribute of a resource or a program. As the assessment is completed and metrics and indicators are developed, PSE will be able to identify specific actions to ensure equitable distribution of benefits and reduction of burdens in the final IRP.

3. CLEAN RESOURCE ADDITIONS 10-YEAR SUMMARY

Conservation Potential Assessment

Demand-side resource (DSR) alternatives are analyzed in a Conservation Potential Assessment and Demand Response Assessment (CPA) to develop a supply curve that is used as an input to the IRP portfolio analysis. The portfolio analysis then determines the maximum amount of energy savings that can potentially be captured without raising the overall electric or natural gas portfolio cost. This identifies the cost-effective level of DSR to include in the portfolio. The full assessment is included in Appendix E.

PSE included the following demand-side resource alternatives in the CPA that was performed by The Cadmus Group for this IRP. While these were evaluated through the CPA process for this IRP, the CEIP establishes specific targets for renewable energy, energy efficiency and demand response, and may evaluate programs aligned with those categories to better reflect and evaluate the targets.

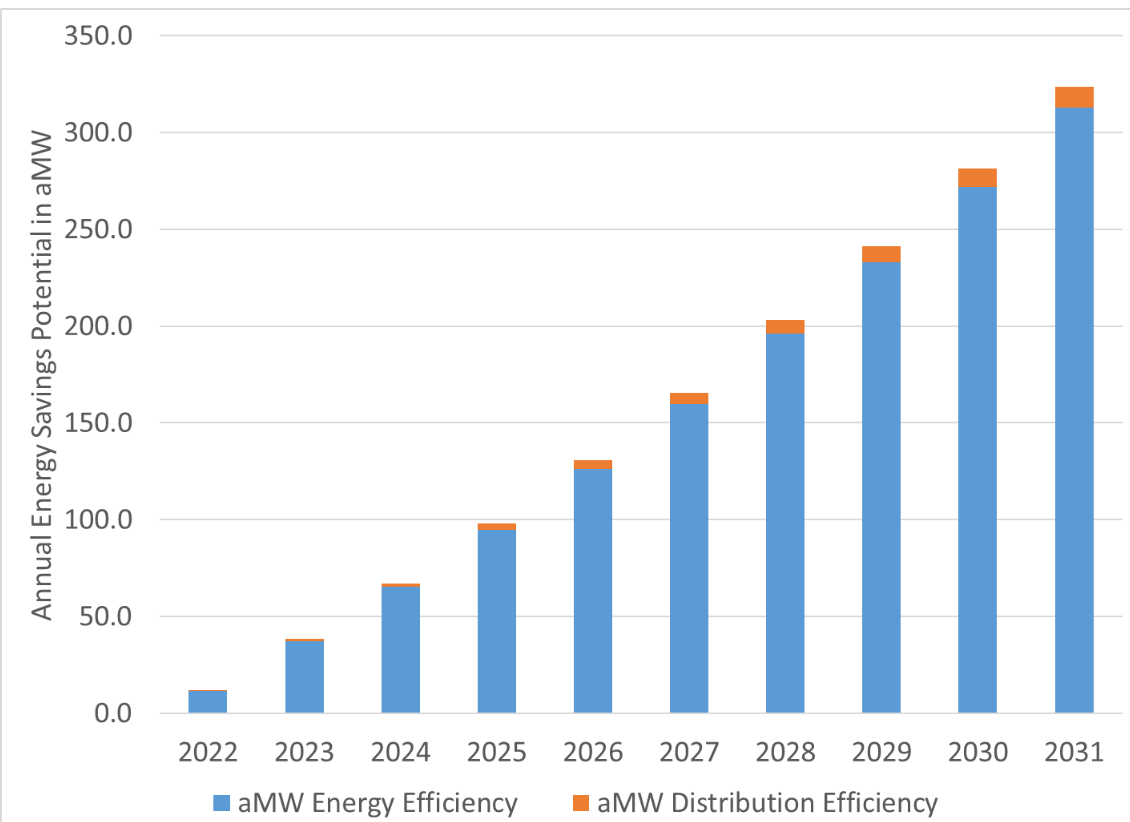
- **ENERGY EFFICIENCY MEASURES.** This includes a wide variety of measures that result in a smaller amount of energy being used to do a given amount of work. These include retrofitting programs such as heating, ventilation and air conditioning (HVAC) improvements, building shell weatherization, lighting upgrades and appliance upgrades.
- **DEMAND RESPONSE (DR).** Demand response resources are comprised of flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost.
- **DISTRIBUTED GENERATION.** Distributed generation refers to small-scale electricity generators located close to the source of the customer's load on customer's side of the utility meter. The CPA includes combined heat and power (CHP) and customer-owned rooftop solar. Additional distributed energy resources are evaluated in this IRP and described below.
- **DISTRIBUTION EFFICIENCY (DE**). This involves conservation voltage reduction (CVR) which is the practice of reducing the voltage on distribution circuits to reduce energy consumption, as many appliances and motors can perform properly while consuming less energy. Phase balancing is required for CVR to eliminate total current flow energy losses.
- **CODES AND STANDARDS (C&S).** These are no-cost energy efficiency measures that work their way to the market via new efficiency standards set by federal and state codes and standards. Only those that are in place at the time of the CPA study are included.

Figure 2-1: 10-year Demand Side Resource Savings

Demand-side Resources	Nameplate (MW)	Energy Savings in 2031 (aMW)	Peak Sapacity in 2031 (MW)
Energy Efficiency	458 MW	266 aMW	458 MW
Distributed Generation: Solar PV	58 MW	7 aMW	1 MW
Distribution Efficiency	12 MW	11 aMW	12 MW
Codes and Standards	169 MW	93 aMW	177 MW

NOTES
1. Demand response is not included in the cost-effective DSR. It is included separately below.
2. Customer solar PV is the only distributed resource modeled as a separate measure, CHP is included in energy efficiency.

Figure 2-2: Electric Achievable Technical Potential Forecast Cumulative 2022 - 2045



The draft IRP analysis looks at the amount of energy efficiency that is cost effective to meet the portfolio's capacity and energy needs, optimizing lowest cost against distributed and centralized resources. PSE's draft analysis indicates that although current market power prices are low, accelerating acquisition of DSR continues to be a least-cost strategy to meet the renewable requirements. Significant changes in avoided cost because of CETA renewable requirements had a huge impact how much conservation could be acquired cost effectively. Because of the large amounts of renewable resources needed, the portfolio is moving into higher cost demand-side resources to meet that need. Conservation lowers the load so that less renewable resources are needed to meet the 100 percent renewable requirement by 2045. Figure 2-3 below is a table of the total nameplate additions of energy efficiency, customer solar PV forecast, distribution efficiency and codes and standards.

Figure 2-3: Cost-effective Demand-side Resources

Incremental Nameplate Additions

Nameplate Additions (MW)	2022-2025	2026-2030	2030 Total
Demand-side Resources	256 MW	360 MW	616 MW
Energy Efficiency	157 MW	245 MW	402 MW
Distributed Generation: Solar PV	2.5 MW	37.7 MW	40.2 MW
Distribution Efficiency	3.9 MW	6.3 MW	10.2 MW
Codes and Standards	92 MW	71 MW	163 MW

NOTES
1. Demand Response is not included in the cost-effective DSR. It is included separately below.
2. Customer solar PV is the only distributed resource modeled as a separate measure, CHP is included in energy efficiency.

Resource Adequacy

PSE has established a 5 percent loss of load probability (LOLP) resource adequacy metric to assess the physical resource adequacy risk. LOLP measures the *likelihood* of a load curtailment event occurring in any given simulation regardless of the frequency, duration and magnitude of the curtailment(s). Therefore, the likelihood of capacity being lower than the load, occurring anytime in the year, cannot exceed 5 percent.

As an important part of resource adequacy analysis, PSE quantifies the peak capacity contribution of renewable (wind, hydro and solar) resources (its effective load carrying capacity, or ELCC) to assess the amount of peak capacity each resource can reliably provide. ELCC is calculated as the change in capacity of a perfect capacity resource that results from adding a different resource with any given energy production characteristics to the system while keeping the 5 percent LOLP resource adequacy metric constant. By using this calculation, the capacity contribution of different resources such as wind, solar and hydro can be identified. Energy-limited resources such as batteries and demand response programs use a similar methodology but use expected unserved energy (EUE) metric aligned with the 5 percent LOLP resource adequacy metric because it better captures adequacy impacts of longer duration, which may deplete energy storages. Further details on the resource adequacy metrics and analysis can be found in Chapter 7.

Figure 2-4 shows the estimated peak capacity contribution or ELCC of the wind resources included in this IRP. The order in which the existing and prospective wind projects were added in the model follows the timeline of when these wind projects were acquired or about to be acquired. Also important to the ELCC calculation is the concept of saturation of resources. Each incremental resource added in the same geographical area provides less effective peak capacity because it provides more of the same resource profile, rather than increasing the diversity of the resource profile. The ELCC calculation for the first 100 MW of the resource is shown below in Figure 2-4 and the full saturation curve for up to 2,000 MW of Washington wind and solar is shown in Figure 2-5.

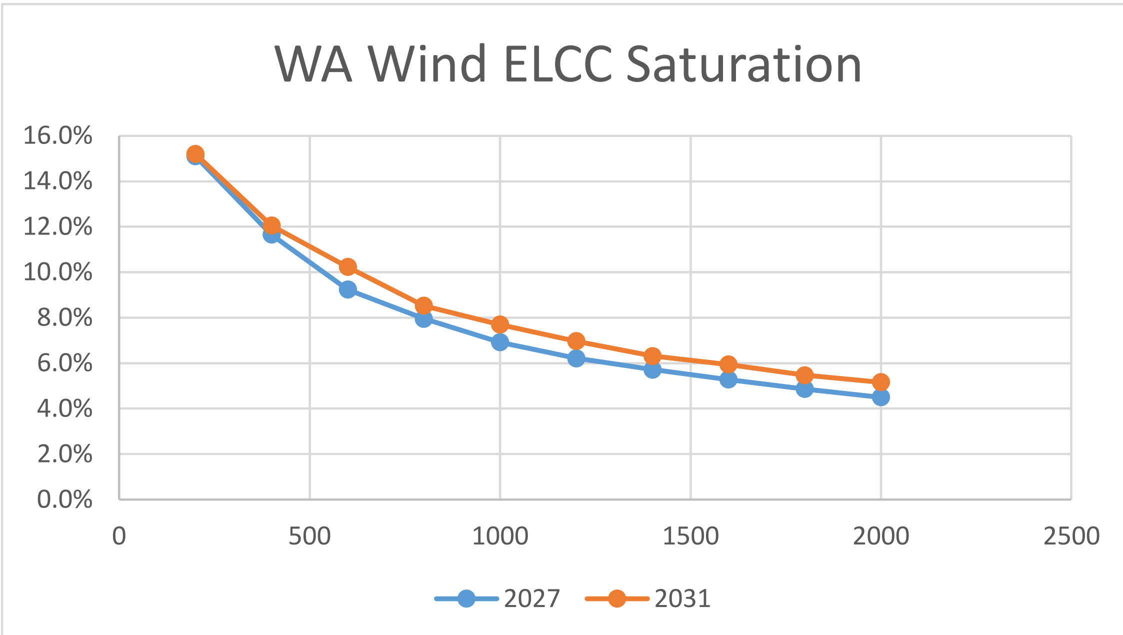
Figure 2-4: Peak Capacity Credit for Wind and Solar Resources

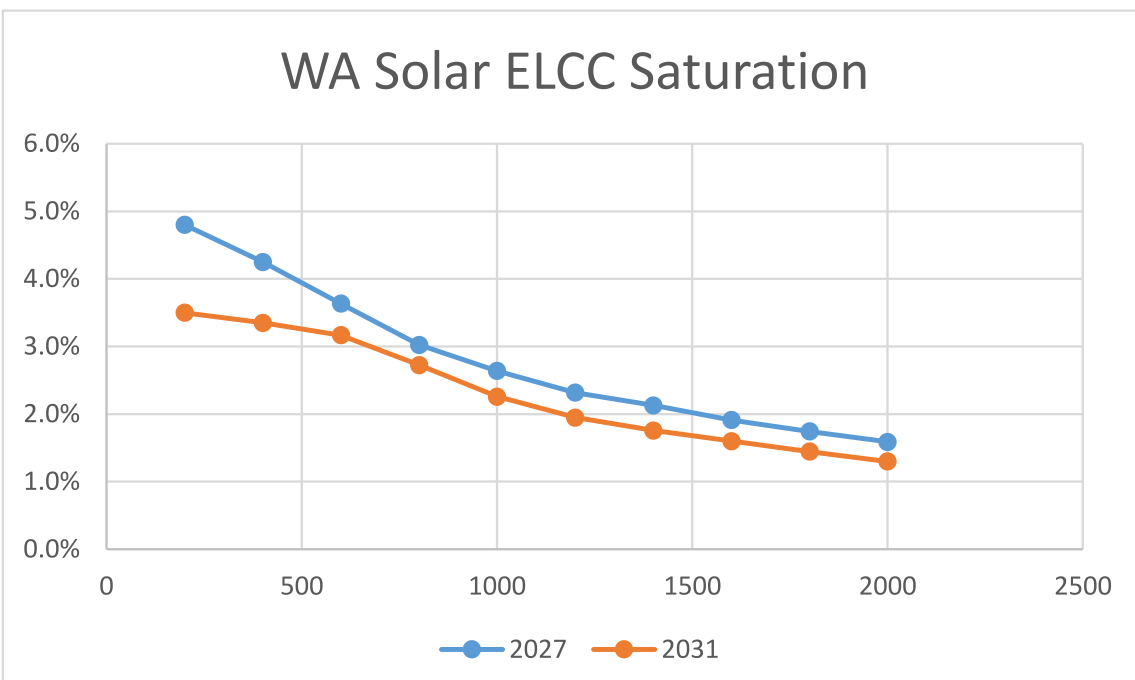
Based on 5% LOLP

WIND AND SOLAR RESOURCES	2021 IRP Year 2027	2021 IRP Year 2031
Existing Wind	9.6%	11.2%
Skookumchuck Wind	29.9%	32.8%
Lund Hill Solar	8.3%	7.5%
Golden Hills Wind	60.5%	56.3%
Generic MT East Wind1	41.4%	45.8%
Generic MT East Wind2	21.8%	23.9%
Generic MT Central Wind	30.1%	31.3%
Generic WY East Wind	40.0%	41.1%
Generic WY West Wind	27.6%	29.4%
Generic ID Wind	24.2%	27.4%
Generic Offshore Wind	48.4%	46.6%
Generic WA East Wind[1]	17.8%	15.4%
Generic WY East Solar	6.3%	5.4%
Generic WY West Solar	6.0%	5.8%
Generic ID Solar	3.4%	4.3%
Generic WA East Solar[1]	4.0%	3.6%
Generic WA West Solar – Utility scale	1.2%	1.8%
Generic WA West Solar – DER Roof	1.6%	2.4%
Generic WA West Solar – DER Ground	1.2%	1.8%

ELCC saturation curves. Figure 2-5 shows a decreasing ELCC as more wind or solar is added in the same region.

Figure 2-5: Saturation curves for Washington Wind and Solar





STORAGE CAPACITY CREDIT. The estimated peak contribution of two types of batteries were modeled as well as pumped hydro storage. The lithium-ion and flow batteries modeled can be charged or discharged at a maximum of 100 MW per hour up to two, four or six hours duration when the battery is fully charged. For example, a four-hour duration, 100 MW battery can produce 400 MWh of energy continuously over four hours. Thus, the battery is energy limited. The estimated peak contribution of the types of storage resources modeled in the IRP is shown in Figure 2-6. The peak capacity contribution for battery storage is low because batteries are relatively short-duration resources. Unlike generating resources, battery storage resources have to recharge; therefore, when long-duration needs for energy occur, they can provide little contribution as compared to generating resources. Storage resources with longer durations provide better peak capacity credits.

Figure 2-6: Peak Capacity Credit for Battery Storage Based on EUE at 5% LOLP

BATTERY STORAGE	Capacity (MW)	2021 IRP Year 2027	2021 IRP Year 2031
Lithium-ion, 2 hr, 82% RT efficiency	100	12.4%	15.8%
Lithium-lin, 4 hr, 87% RT efficiency	100	24.8%	29.8%
Flow, 4 hr, 73% RT efficiency	100	22.2%	27.4%
Flow, 6 hr, 73% RT efficiency	100	29.8%	35.6%
Pumped Storage, 8 hr, 80% RT efficiency	100	37.2%	43.8%

DEMAND RESPONSE CAPACITY CREDIT. The capacity contribution of a demand response program is also estimated using EUE, since this resource is also energy limited like storage resources. The same methodology was used as for storage resources. The estimated peak capacity contribution of demand response is shown in Figure 2-7.

Figure 2-7: Peak Capacity Credit for Demand Response based on EUE at 5% LOLP

DEMAND RESPONSE	Capacity (MW)	2021 IRP 2027	2021 IRP 2031
Demand Response, 3 hr duration, 6 hr delay, 10 calls per year	100	26.0%	31.6%
Demand Response, 4 hr duration, 6 hr delay, 10 calls per year	100	32.0%	37.4%

Demand Response

Demand response programs are voluntary, and once enrolled, customers usually receive notifications in advance of forecasted peak usage times requesting them to reduce their energy use. Some program types require action by the customer, whereas others can be largely automated. In an example of an automated program, this might mean that the customer's thermostat automatically warms their home or building earlier than usual. Because of the remote function of demand response, no action is required from customers to initiate their reduction in load, and they can always choose to opt out of an event. In an example of a program type that requires customer action, a wastewater plant may be asked to curtail pumping during certain peak energy need hours if they can operationally do so.

Demand response programs modeled for this IRP are organized into four categories. These include:

- Direct Load Control (DLC)
- Commercial and Industrial (C&I) Curtailment
- Dynamic Pricing or Critical Peak Pricing (CPP)
- Behavioral DR

Figure 2-8 lists the estimated resource potentials for all winter demand response programs modeled for the residential, commercial and industrial sectors during winter. The total DR nameplate achievable potential is 228 MW. The peak capacity credit of demand response programs is shown in Figure 2-7. To illustrate the total impact on system peak, the system peak load is also shown in Figure 2-XX. This system peak was calculated as the average of PSE's hourly loads during the 20 highest-load hours in the winter of 2019. Further details can be found in Appendix D.

Figure 2-8: Demand Response Achievable Potential and Levelized Cost by Product Option, 2045

Program	Product Option	Winter Achievable Potential (MW)	Winter Percent of System Peak	Levelized Cost ($/kW-year)
Residential CPP	Res CPP-No Enablement	64	1.28%	-$3
	Res CPP-With Enablement	2	0.04%	-$8
Residential DLC Space Heat	Res DLC Heat-Switch	50	1.00%	$71
	Res DLC Heat-BYOT	3	0.06%	$61
Residential DLC Water Heat	Res DLC ERWH-Switch	11	0.21%	$126
	Res DLC ERWH-Grid-Enabled	58	1.15%	$81
	Res DLC HPWH-Switch	< 1	< 0.1%	$329
	Res DLC HPWH-Grid-Enabled	1	0.02%	$218
Commercial CPP	C&I CPP-No Enablement	1	0.03%	$86
	C&I CPP-With Enablement	1	0.02%	$81
Commercial DLC Space Heat	Small Com DLC Heat-Switch	7	0.13%	$64
	Medium Com DLC Heat-Switch	5	0.10%	$29
Commercial and Industrial Curtailment	C&I Curtailment-Manual	3	0.06%	$95
	C&I Curtailment-AutoDR	3	0.06%	$127
Residential EVSE	Res EV DLC	9	0.17%	$361
Residential Behavioral	Res Behavior DR	9	0.17%	$76

This IRP evaluated 16 different demand response programs and 14 of those were found to be cost effective. To reflect the time needed to enroll customers in programs, 4 of the programs ramped in starting in 2022 and the remaining 10 programs ramped in starting in 2025. The four programs starting in 2022 were part of the least cost optimization in most of the portfolio sensitivities. Demand response takes a couple of years to set up before savings are achieved, so even with four programs starting in 2022, the total nameplate by 2025 is only 10 MW because of the time it takes to establish the programs and enroll customers. The total DR program size grows to 161 MW nameplate capacity by 2030.

Figure 2-9: Cost-effective Demand Response Incremental Nameplate Capacity

Resource Additions (MW)	2022-2025	2026-2030	Total
Demand Response	10 MW	161 MW	171 MW

Renewable Resources

For this IRP, wind was modeled in seven locations throughout the northwest United States, including eastern Washington, central Montana, eastern Montana, Idaho, eastern Wyoming, western Wyoming and off the coast of Washington. Solar was modeled as a centralized, utility-scale resource at several locations throughout the northwest United States.

Energy storage resources were modeled in combination with the renewable resources. Two battery storage technology systems were analyzed, lithium-ion and flow technology. These systems are modular and made up of individual units that are generally small. Batteries provide both peak capacity and sub-hourly flexibility value. Pumped hydro storage resources are generally large, on the order of 250 to 3,000 MW. This analysis assumes PSE would split the output of a pumped hydro storage project with other interested parties. PSE analyzed an 8-hour pumped hydro resource. In addition to stand-alone generation and energy storage resources, PSE modeled hybrid resources which combine two or more resources at the same location to take advantage of synergies between the resources. PSE modeled three types of hybrid resources, including eastern Washington solar + 2-hour lithium-ion battery, eastern Washington wind + 2-hour lithium-ion battery, and Montana wind + pumped hydro.

This IRP found that Montana and Wyoming wind power is expected to be more cost effective than wind and solar from the Pacific Northwest. Given transmission constraints, resources out of the Pacific Northwest region are limited. The timing of renewable resource additions is driven by CETA renewable requirements and is shown in Figure 2-10 below.

Figure 2-10: Renewable Resources Incremental Nameplate Capacity

Resource Additions (MW)	2022-2025	2026-2030	Total
Renewable Resources	600 MW	1,100 MW	1,700 MW

Distributed Energy Resources

While the adoption of distributed energy resources (DER) is still low in PSE's service territory, about 1 percent of PSE customers are participating in net metered solar, with an installed capacity of approximately 85 MW. As DER technology evolves and prices decline, customer adoption will increase. DERs will play an important role balancing utility-scale renewable investments and transmission constraints while also meeting local distribution system needs.

In this IRP, PSE specifically included several different types of distributed energy resources. In addition, demand response, which is considered a distributed energy resource, was also modeled in this IRP as previously discussed.

BATTERY ENERGY STORAGE. Two distributed battery storage technology systems were analyzed: lithium-ion and flow technology. These battery storage systems are modular and made up of individual units that are generally small. Batteries provide both peak capacity and sub-hourly flexibility value. In addition, since they are small enough to be installed at substations or on the distribution system, they can potentially defer local transmission or distribution system investments. PSE analyzed 2-hour and 4-hour lithium-ion batteries, as well as, 4-hour and 6-hour flow battery systems.

DISTRIBUTED SOLAR GENERATION. Distributed solar generation refers to small-scale rooftop and ground-mounted solar panels located close to the source of the customer's load. Distributed solar was modeled as a residential-scale resource in western Washington.

NON-WIRES ALTERNATIVES. The role of distributed energy resources (DER) in meeting delivery system needs is changing and the planning process is evolving to reflect that change. Non-wires alternatives are being considered when developing solutions to specific, long-term needs identified on the transmission and distribution systems. The resources under study have the benefit of being able to address system deficiencies while simultaneously supporting resource needs and can be deployed across both the transmission and distribution systems, providing some flexibility with how system deficiencies are addressed. The non-wires alternatives considered during the planning process include energy storage systems and solar generation.

Figure 2-12: Distributed Energy Resources Incremental Nameplate Capacity

Resource Additions (MW)	2022-2025	2026-2030	Total
Distributed Energy Resources			
Battery Energy Storage	75 MW	125 MW	200 MW
Solar - ground and rooftop	80 MW	150 MW	230 MW
DSP Non-Wire Alternatives	22 MW	24 MW	46 MW
Total DER	177 MW	299 MW	476 MW

4. DELIVERABILITY OF RESOURCES

PSE will work to optimize use of its existing regional transmission portfolio to meet our growing need for renewable resources in the near term, but in the long term, the Pacific Northwest transmission system may need significant expansion, optimization and possible upgrades to keep pace. The main areas of high-potential renewable development are east of the Cascades (Washington and Oregon), in the Rocky Mountains (Montana, Wyoming), in the desert southwest (Nevada, Arizona) and in California. The specific opportunities for expanding transmission capabilities and regional efforts to coordinate transmission planning and investment are described in detail in Appendix J.

Investments in the delivery system are needed to deliver energy to PSE's customers from the edge of PSE's territory and support DERs within the delivery grid. The delivery system 10-year plan described in Appendix M identifies work that is needed to ensure safe, reliable, resilient, smart and flexible energy delivery to customers, irrespective of resource fuel source. These include specific upgrades to the transmission system to meet NERC compliance requirements and other evolving regulations related to DER integration and markets and to the distribution system to enable higher DER penetration. Specific delivery system investments will become known when energy resources siting, whether centralized or DERs, begins through the established interconnection processes. The readiness of the grid and customers for DER integration will decrease the cost for interconnection and increase the number of viable locations. Proactive investments in grid modernization are also critical to support the clean energy transition and maximize benefits. The key investment areas are summarized below.

Data

Data availability, integrity and granularity are critical aspects to planning for and operating DERs. Through our ongoing investment in Advanced Metering Infrastructure (AMI) and SCADA at distribution substations, PSE will have new data and visibility that can be utilized for delivery system planning, customer program planning and operational analytics. AMI is an integrated system of smart meters, communications networks and data management systems that enables two-way communication between utilities and customers. AMI meters will serve to provide significant enhancements to the types and granularity of data PSE can collect to proactively plan for growth, integrate new technologies, offer services to customers, respond to system needs quicker and operate the system safely. SCADA provides real-time visibility and remote control of distribution equipment to reduce duration of outages, improve operational flexibility and enhance overall reliability of the distribution system.

In addition to utilizing new data, PSE recognizes the importance of maintaining and augmenting the data that we already have, particularly the asset data within our Geographic Information System (GIS). PSE is working to evolve GIS processes so that changes in the field can be quickly incorporated and so that data such as DER asset information is collected and displayed. GIS connects with many enterprise systems, and GIS data will be increasingly central to the ability to plan for and operate DERs. Finally, data analytics programs will support optimization of customer service and system operations including predicting asset replacement needs before failure as DERs are added to the grid.

Monitoring, Control and Metering

In addition to SCADA and AMI investments, PSE is currently implementing an Advanced Distribution Management System (ADMS). ADMS is a computer-based, integrated platform that provides the tools to monitor and control our distribution network in real time. The implementation of ADMS will ultimately lead to advanced operational capabilities for DERs including an integrated Distributed Energy Resource Management System (DERMS).

Other advanced capabilities such as Volt-Var Optimization (VVO) and Fault Location, Isolation, Service Restoration (FLISR) will be enabled through the ADMS platform and additional investments in reclosers, switches, voltage regulators, capacitors banks and network communications infrastructure. FLISR will support grid reliability to enable battery energy storage charging and transportation electrification. VVO will manage voltage and reactive power as loads shift due to DER implementation.

DER Forecasting and Planning

PSE plans to implement a geospatial load forecasting tool that includes DER forecasting capabilities as well as end-use forecasting information that supports our energy efficiency and demand response programs. With this tool we can understand not only the anticipated growth of DERs, but also the specific feeder locations. This will enable proactive system investments and potentially uncover targeted demand-side management options and support non-wires alternatives. PSE will continue to enhance its modeling tools and capabilities to ensure grid stability.

Security

While pursuing our grid modernization strategy, PSE will continue to put a strong focus on cyber-security. PSE applies the same level of due diligence across the enterprise to ensure risks are consistently addressed and mitigated in alignment with the rapidly changing security landscape. PSE utilizes a variety of industry standards to measure maturity as each standard approaches security from a different perspective. As critical infrastructure technology becomes more complex, it is even more crucial for PSE to adapt and mature cyber-security practices and programs allowing the business to take advantage of new technical opportunities such as Internet of Things (IoT) devices. In addition, we continue to foster strong working relationships with technology vendors to ensure their approach to cyber-security matches PSE's expectations and needs.

PSE will also pursue energy security and resiliency investments such as microgrids or infrastructure hardening where specific locations require increased resilience. These locations could include highly impacted communities, transportation hubs, emergency shelters and areas at risk for isolation during significant weather events or wildfires.

Infrastructure Assets

To avoid reactive investments due to unanticipated DER adoption and integration and in addition to the work already described, PSE will pursue targeted, proactive asset management and system upgrades to enable DER integration and transportation electrification. Grid modernization investments will improve the reliability of our systems, improve the ability to withstand and recover from extreme events, and enable smart and flexible grid capabilities. Ongoing and site-specific asset investments are needed such as pole replacement, tree-wire conductor and cable remediation programmatic transformer replacements as DERs and electric vehicles propagate, and substation and circuit enhancements that ensure or expand DER effectiveness. Finally, PSE will continue to upgrade its local transmission system in order to meet NERC compliance requirements and evolving regulations related to DER integration and markets and meet peak demand reliably.

5. ALTERNATIVE COMPLIANCE OPTIONS

Under CETA, up to 20 percent of the 2030 greenhouse gas neutral standard can be met with an alternative compliance option. These alternative compliance options can be used beginning January 1, 2030 and ending December 31, 2044. In order to model the alterative compliance options as part of the portfolio modeling, PSE evaluated two alternative compliance options. For the first option, PSE assumed that renewable energy credits would be purchased for 20 percent of load not met by renewable generation starting in 2030 and decreasing linearly to zero in 2045. Because there isn't a transparent forecast of the future price of renewable energy credits, PSE used the California carbon price as a proxy, as this may align with the requirement for greenhouse gas neutral electricity. The forecasted prices start at over $34 per MWh in 2030 and increase to $59 per MWh in 2045. The costs are included in all the portfolios as part of meeting the 2030 standard.

In addition to using carbon prices as a proxy price for renewable energy credits, PSE also modeled a portfolio sensitivity to understand the impact of meeting the 20 percent of load with renewable resources such that 100 percent of PSE's load is met with renewable resources. This compliance option has a total 24-year NPV of over $34 billion, $15 billion more than the preferred portfolio. This portfolio is described in detail in Sensitivity N in Chapter 8.

Actual compliance may be met through other mechanisms that are still under development and may include energy transformation projects, unbundled RECs and other options. As the Department of Ecology develops guidance on methods for assigning greenhouse gas emission factors for electricity, establishes a process for determining what types of projects may be eligible as energy transformation projects, and includes other options such as transportation electrification, PSE will analyze these mechanisms.

6. SOCIAL COST OF GREENHOUSE GASES

The SCGHG is applied as a cost adder in the development of the electric price forecast and in the portfolio modeling process when considering resource additions. The SCGHG is not included in the final dispatch of resources because it is not a direct cost paid by customers. CETA explicitly instructs utilities to use the SCGHG as a cost adder when evaluating conservation efforts, developing electric IRPs and CEAPs, and evaluating resources options. The SCGHG cost adder is included in planning decisions as part of the fixed O&M costs of that resource, but not in the actual cost and dispatch of any resource. An SCGHG adder is also added to the unspecified market purchases using the 0.437 metrics tons CO_2/MWh emission rate as specified in CETA.

The SCGHG in CETA comes from the Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document, August 2016 update. It projects a 2.5 percent discount rate, starting with $62 per metric ton (in 2007 dollars) in 2020. The document lists the *CO_2* prices in real dollars and metric tons. PSE has adjusted the prices for inflation (nominal dollars) and converted to U.S. tons (short tons). This cost ranges from $69 per ton in 2020 to $238 per ton in 2052. Further details can be found in Chapter 5.