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WITNESS: DAVID J. LANDERS

**BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, Complainant, v. PUGET SOUND ENERGY, Respondent.	Docket UE-240004 Docket UG-240005

**APPENDIX A (NONCONFIDENTIAL) TO THE FOURTH EXHIBIT TO THE
PREFILED DIRECT TESTIMONY OF**

DAVID J. LANDERS

ON BEHALF OF PUGET SOUND ENERGY

FEBRUARY 15, 2024

GRID MODERNIZATION
Strategy

PSE PUGET SOUND ENERGY

MAY 2023

Contents

1. Executive Summary 1
2. Introduction 2
3. The Need to Modernize the Grid is Clear 3
4. Grid Modernization Vision, & Guiding Principles 6
   4.1 Vision 6
   4.2 Guiding Principles for Action 7
5. Grid Modernization Strategy Objectives 7
6. Grid Sustainment & Advancement Tactics 9
   6.1 Grid Sustainment: Continuing Investments 9
   6.2 Grid Advancement: Technology Investments 10
7. Supporting Activities 11
   7.1 Integrating and Expanding Delivery System Planning 11
   7.2 Broadening Knowledge and Input through a Changed Approach to Stakeholder Engagement 11
   7.3 Identifying Skills to Transition to the Future 12
   7.4 Organizational Intersections 13
8. Measureable Outcomes 14
9. Roadmap 17

Appendix A – Grid Mod Investment Descriptions 19
   Grid Sustainment: Continuing Investments 19
   Grid Advancement: Developing Technologies 20
Appendix B – Delivery System Planning Operating Model 24
Acronyms 26
Glossary 27
Authors & Revision History 31

1. Executive Summary

Many factors have led Puget Sound Energy (PSE) to a unified Grid Modernization Strategy. PSE's mission is to be safe, clean and reliable. Our direction – or north star – is to be our customers' clean energy partner of choice. Investments made to modernize the grid support our mission and move us in the direction of our north star. The technical and organizational complexity of planning, building, and operating a modern grid to serve all customers while advancing energy equity across our service area requires a strategic approach of interdependent investments in reliability, resiliency and operational flexibility that prioritizes value to the customer. While deployment of new evolving technologies help PSE advance capabilities of the grid, we continue to simultaneously invest in sustaining our existing infrastructure to maintain the service our customers have relied on for over 140 years.

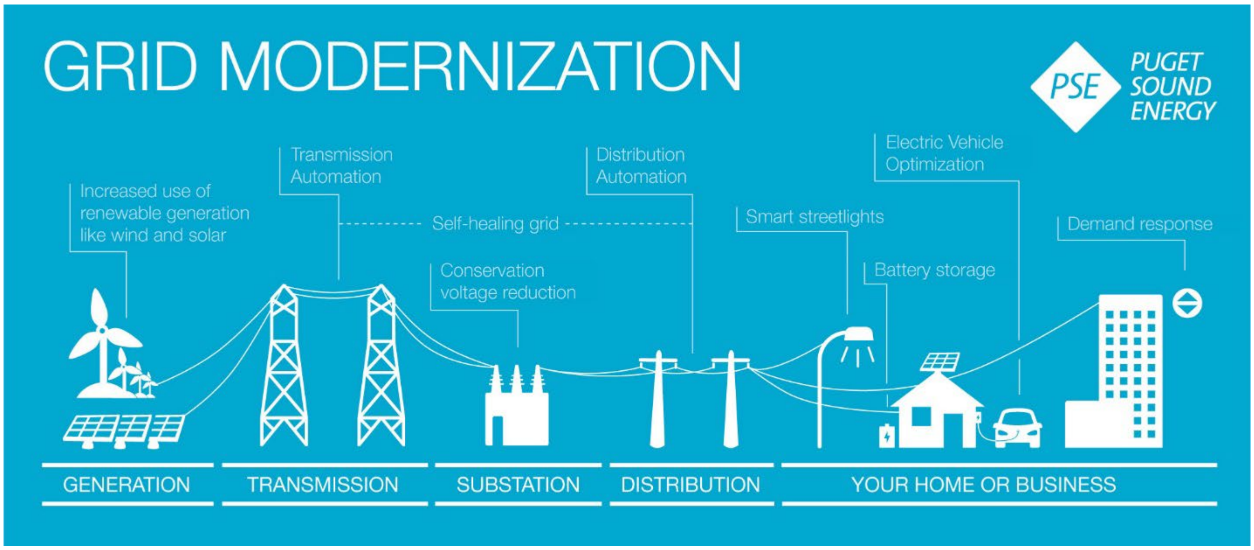
This document first encapsulates drivers and needs for a Grid Modernization strategy. Then we move to establishing our vision and guiding principles to achieve the future grid. Next, we discuss how grid Sustainment and Advancement program tactics planned over the next decade support the Grid Modernization strategy. In addition to implementing this strategy, there are many activities across the company that support our modern grid, including a focus on development of a workforce prepared with necessary skills to operate a modern grid and processes to support project and program implementation. Finally, we define success with metrics that, when met, will ensure we are on track to delivering desired results and benefits for customers.

As new technologies emerge, customer expectations change, and public policy and regulations evolve, the Grid Modernization Strategy will continue to develop. Regardless of the technologies deployed, we will continue to invest in our infrastructure, tools, and processes to deliver on our mission. Grid Modernization brings value to customers by enabling the clean energy transformation while maintaining and improving grid reliability and resilience. We deliver this value through a comprehensive and holistic approach to advancing new grid capabilities while sustaining existing capabilities. This approach is dependent on and closely coordinated with other enterprise activities such as telecommunications and cybersecurity, and supports new customer programs like time-of-use rates and demand response. Guiding principles for action provide focus for programs today with forward-looking and proactive direction for the smart and flexible grid of the future. We define success and are accountable to others with tangible metrics including number of EVs enabled and percent of the distribution system with SCADA.

PSE's Grid Modernization Strategy begins a dialogue around how to deliver the business and technical capabilities to serve customers safely, reliably, and resiliently in a digital era. Our efforts enable integration of clean energy resources, support equitable access to energy, and ensure accountability to our customers in delivering benefits of a modern grid.

2. Introduction

PSE's Grid Modernization Strategy informs an integrated and holistic approach to sustaining and advancing the electric system for the benefit of all PSE customers. PSE's north star is to be our customers' clean energy partner of choice. Grid modernization plays a key role by sustaining and advancing existing grid capabilities, while enabling and receiving benefits from new and emerging technologies such as distributed energy resources and electric vehicles. The Grid Modernization Strategy brings a focus to the building blocks necessary for transition to the electric grid of the future.



The modern grid is a reliable, resilient, smart, flexible and safe system that enables integration of clean technologies, advances equity and maintains affordability. The energy industry is rapidly transforming, and having a Grid Modernization Strategy is instrumental to building the system our customers need. This pathway to change requires technical competencies combined with diverse and committed collaboration. PSE strives to join forces with customers, communities, research institutions, peer utilities and others to clarify the needs and develop effective solutions. Therefore, PSE's Grid Modernization Strategy guides a continuing dialogue to target objectives and investments that will build the grid of the future.

3. The Need to Modernize the Grid is Clear

The timely alignment of need drivers has accelerated the rate of change in the electric power industry and within PSE. Customers are informed and looking for new experiences in how they interact with the electric system and PSE. In addition, society's dependence on the electric system is on a trajectory to substantially increase with clean energy transformation. The increased customer expectations have been coupled with technology advancements that unlock new capabilities.

Understanding and clarifying the needs helps set a solid foundation for imagining and envisioning the grid of the future.

CUSTOMER EXPECTATIONS & EQUITY

More than ever, customers are seeking out available clean energy options, expect greater reliability, desire the confidence of resiliency, and want to clearly see value and equity in resources acquired and energy delivered. Changing expectations have been driven by increased access to information regarding energy resources and increased e-commerce by other industries, within the context of critical conversations about equity in our society. Customers have become accustomed to being empowered with options. While reliable service remains a priority, more and more customers are installing their own renewable generation, and requesting support for new technologies such as battery storage and EV charging for their homes and businesses. At the same time, customers from highly impacted communities and vulnerable populations may be less aware of available programs and may experience barriers in accessing programs and services (e.g., language accessibility, renters vs. ownership, high cost of new technologies, etc.). With CETA, PSE has a responsibility to ensure programs and investments advance energy equity, with equity considerations embedded in clean electricity planning, decisions and transformation, and Customer Benefits Indicators utilized in measuring performance.

INCREASING DEPENDENCY

Electric power customers have an ever-increasing dependence on the stability of the electric system. Electricity is part of the critical infrastructure that fuels society. The criticality of the system is escalating with the transition to electric vehicles, greater adoption of electric appliances, growing dependence on digital information and services, and increased penetration of customer-owned distributed energy resources. The resourcing of electricity and associated power quality, reliability (outages) and resiliency (ability to withstand extreme events) of the selected resources have significant impact to customers financially, physically and mentally. This reality of growing dependency on the electric system increases the need for improving reliability and resiliency in a cost effective manner.

ACCELERATED TECHNOLOGY ADVANCEMENTS

The increased pace and rate of technology development has introduced a greater need for systems integration and awareness of complexities involved in system interrelationships. The presence of new technology has unlocked emerging potential to advance the electric system and meet the increasing expectations of customers. The development of customer distributed energy resources, renewables, microprocessor relays, communication pathways, IT architecture, software, automation and optimization presents opportunities to develop new capabilities on behalf of customers.

POLICY & REGULATORY

Dating as far back as 2010, Washington State requirements for utility reporting on smart grid technology evaluation has encouraged electric utilities' preparation and progress towards a "smart grid" that enables many elements outlined in future policies including the advancement of digital information relating to electricity use, costs, prices, and storage and delivery signals to allow end use load device automation, controlling and managing electricity demand, voltage control, and frequency regulation. It encourages progress in advancing the grid's ability to sense local disruptions or changes in power flow, to use two-way communication to enable different customer contracts or programs, to manage new end-use services to reduce operating or power costs, and to use digital information in an integrated manner to improve flexibility, functionality, interoperability, cyber-security, situational awareness, and operational efficiency of the transmission and distribution system. In 2019, the Washington State legislature passed the Clean Energy Transformation Act (CETA), one of the most comprehensive carbon laws in the nation that sets the pace for clean energy transformation. RCW 19.280.100 "Distributed Energy Resource Planning" under the Electric Utility Resource Plans Chapter establishes an expectation for DER Planning. At the federal level, FERC-2222 and other developments will shift the policies and regulatory climate at an industry level to give freedom for development in some areas and obligate development in others. Moving forward it will become more important to mindfully engage with the regulatory institutions to align grid advancements with expectations and enable PSE to steward the environment, empower communities and develop the business.

SEVERE NATURAL EVENTS

Global, national, and local natural events have brought awareness to the need for an electric system able to withstand or recover from increasing environmental extremes. The recent electric system impacts from wildfires, heat waves, cold snaps, earthquakes, droughts, severe winds, and even pandemics have introduced a need to consider design parameters for increasing the system resiliency amidst such events.

SAFETY & SECURITY

Ensuring the safety and security of the physical electric system and cyber systems is an ever-evolving challenge. Increases in the criticality of the infrastructure, range of communication networks, quantity of interconnected IT/OT devices, interfaces between internal and external systems, and speed of advancement of technologies presents a need to manage safety, security and cyber security & privacy.

In summary, PSE faces a host of challenges, drivers of change, and opportunities during an exciting time of innovation and collaboration between new players in the industry. In order to successfully face these challenges and meet the emerging needs head-on, a Grid Modernization Strategy must be developed and supported through effective collaboration and partnership between PSE, customers, government and tribal entities, and businesses in order to achieve our vision for the future grid.

4. Grid Modernization Vision, & Guiding Principles

4.1 Vision

The grid of the future must anticipate, facilitate, and integrate new uses, structures and capabilities for how energy is produced, distributed, and utilized. The grid of the future will utilize multidirectional communication and power flow to maximize value for the benefit of all customers. The focus on grid modernization will help PSE maintain our commitments to safety and reliability, enhance system resiliency, and expand investment in smart and flexible technology to provide customers with the service and choices they want long into the future. By enabling the rapid and equitable integration of distributed energy resources, PSE will be our customers' clean energy partner or choice.

The vision for accomplishing this is built upon the "Grid Modernization Triangle" which names five attributes of the future grid and sets the direction toward our objectives and tactics. In almost all cases, grid advancement or sustainment solutions will support multiple attributes. The Grid Modernization Triangle, shown in Figure 1, allows us to represent the interrelatedness of our grid modernization objectives, and ultimately, the interdependence of our investments.

To be our customers' clean energy partner of choice, PSE needs a grid that is:

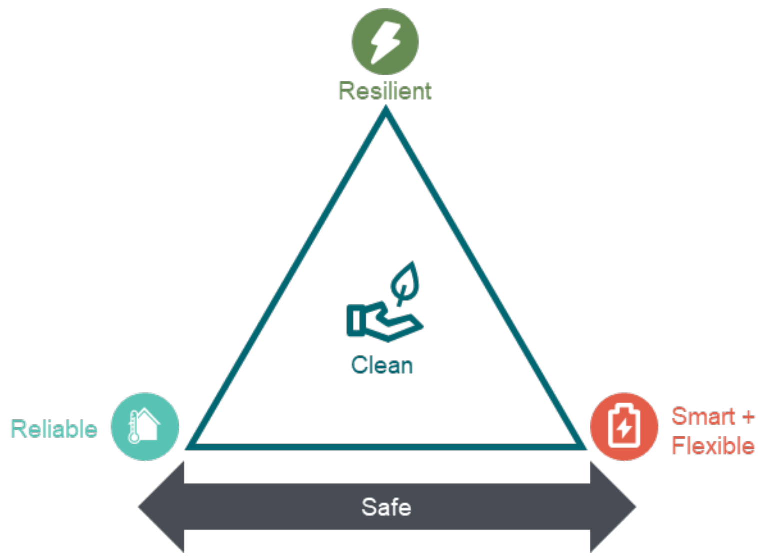


Figure 1: Grid Modernization Triangle

SAFE: Safety for the public, our workforce, and environment continues to be PSE's top priority and sets the foundation for the future grid. It is imperative to maintain and enhance safety, as new technology is explored, evaluated, and implemented at scale.

RELIABLE: PSE must continue to decrease the frequency, duration and impact of power interruptions to meet customer's increasing expectations of and reliance on reliable service. This involves preventing or mitigating the impact of interruption events and learning from those events that occur to improve future performance. Key areas of focus for prevention and mitigation are system design, system maintenance, system operation and event response. Key areas of focus for learning and improving are measuring performance, researching industry best practices, developing advanced analysis tools and integrating information about new regulations and changing customer expectations.

RESILENT: As environmental characteristics change and customers rely more on electric service, high impact, low frequency events may become more common and have greater impact. Similar to reliability, PSE intends to design a system and response mechanisms that minimize the frequency, duration and impact of these events. Key areas of focus right now include system hardening to prevent failures and adding adaptive elements for quick localized recovery from disruptions. The concept of a resilient grid is still evolving. PSE will adapt its strategies as new information about potential high impact events, regulatory policies and changing industry best practices becomes available.

SMART & FLEXIBLE: Adding intelligence to the electric system allows for more automation and technology to save energy and improve customer experience. This also increases the electric system and business flexibility which empowers customers to control their energy choices based on cost, carbon, or other preferences and enables advanced operational options. The use of data and analytics will provide greater situational awareness and support improved forecasts and smarter decision making capabilities.

CLEAN: Enabling the rapid and equitable integration of distributed energy resources and supporting other green technologies, such as electric vehicles.

4.2 Guiding Principles for Action

As present opportunities are implemented and new solutions explored, it is important to be rooted in the core values and principles by which sustainable solutions are derived. The posture in navigating the ambiguity of emerging technologies and addressing new challenges helps to lay the foundations for desired customer focused outcomes. Therefore, the approach to grid modernization relies on defined Guiding Principles for Action.

In the creation of the Grid Modernization Strategy, a cross-functional group of PSE leaders developed six guiding principles for action. These statements steer decisions on where to focus efforts today to prepare for the future, and how customers and other interested parties should be considered. Our guiding principles align with PSE's values: we all have a voice, we do what's right, and we have each other's back.

FORWARD THINKING	Anticipate and drive solutions that enable a future where new sources of energy are renewable and many are distributed.
CUSTOMER FOCUSED	Deliver flexible, segmented, and tailored value propositions that meet our customers' unique needs.
PROACTIVE	Proactively identify trends, and influence regulatory and legislative policy.
FLEXIBLE	Be prepared for, and deliver service through a variety of operating models for customer choice.
TRANSPARENT	Be transparent about decision-making and processes in collaborations with interested parties and customers.
EQUITABLE	Prioritize the principles of energy equity to enhance and align accessibility, affordability, and accountability in planning, design, decision-making and implementation.

5. Grid Modernization Strategy Objectives

Successful implementation and continued commitment to the Grid Modernization Strategy can provide desired results as described in the following:

Enable Customer Choices

The future grid enables customers and communities to leverage smart home technologies, transportation electrification, and distributed energy resources. Customers will have increased availability of their detailed daily usage data, making it easier to leverage smart technologies to use energy more efficiently and cost effectively aided by appropriate rate structuring (e.g. Time Varying Rates). Proactive investments in grid modernization will enable customers to use market available tools on an expanded demographic basis through removing barriers and providing enhanced information.

Bring Value to our Customers

PSE endeavors to keep our customers at the forefront of all the work we do. The aforementioned objectives to build a modern grid are inseparable from this principle. Achieving our goals will bring value to our customers as we continue to provide safe and affordable service while improving reliability and grid resilience. By sustaining the existing grid and investing in new technologies, we will bring shared benefits to all customers. Customers and communities will be empowered through electric vehicle and DER enablement, smart home capabilities, and time varying rate structures.

As we build more value, efficiencies, and capabilities with a modernized grid, we must ensure that all customers and the community as a whole have a share in the benefits. Access to clean technologies and DER interconnection support equity as the grid transforms, including highly impacted communities and vulnerable populations. As we implement infrastructure and customer programs, we strive to keep rates affordable through the prioritization of projects that deliver the greatest benefits today and over time.

Ready the Business and Technical Capabilities to Deliver Results

We aim for aligned business practices and workforce competencies to leverage new technologies. Effective organizational change management will lead us to operating our business in a manner that maximizes anticipated benefits from improved tools, processes, and technical skills.

Future-proof for Evolving Technologies, Preferences, and Business Models

While we endeavor to modernize the grid to accept and leverage the latest industry technologies and customer-accessible tools, we will carry forward lessons learned that will allow for grid integration of future technologies, customer preferences, and business models.

Establish Measurable Outcomes

A key to this effort is managing the work to achieve defined and measureable results. Investments will have direct correlation to benefits that a modern grid provides such as operational efficiency and customer service improvements. Specific metrics of the Grid Modernization program are listed in Section 8.

6. Grid Sustainment & Advancement Tactics

PSE has been on a path to modernize our electric system for decades, though more recent advances in technology have allowed faster movement in development compared to the recent past. Recognizing that the development of the electric system is built from the foundation of existing functionalities, PSE's grid modernization efforts consider two primary categories: 1) Sustainment and 2) Advancement.

6.1 Grid Sustainment: Continuing Investments

In order to build and enhance the grid needed to serve our customers in the future, PSE must continue to sustain existing capabilities of our grid. The electric grid has been providing electricity to our customers for many years, with many assets remaining in service beyond normal operating life. From the numerous poles and wires that span our delivery system to field and substation equipment, the various assets that make up our grid must be evaluated and prioritized for maintenance, like-for-like replacement, or enhancements to preserve and improve reliability and safety of the grid. PSE's robust design and construction standards have drastically improved over the years, which supports a stronger and more resilient grid, enabling advancement towards modernization.

The table below lists ongoing sustainment investments to support grid modernization and indicates to which of the five grid modernization attributes each investment contributes. See Appendix A for a brief description of each of the Sustainment Programs.

Grid Mod Investment – Sustainment	Safe	Clean	Reliable	Resilient	Smart & Flexible
Pole Replacement	SAFE		●	●	
Cable Remediation Program (CRP)			●	●	
Substation Reliability			●	●	●
Targeted Reliability Upgrades			●		
Worst Performing Circuits (WPC)			●	●	●
Resilience Enhancement		●		●	
Root Cause Analysis	SAFE		●	●	
Distribution Reclosers			●	●	●
Fusesavers			●	●	
Wildfire Resilience	SAFE	●	●	●	●

6.2 Grid Advancement: Technology Investments

This section provides a list of technology advancement investments currently underway to drive grid modernization, as well as some of the recently developed technology programs that directly enable technology of our future grid. These technologies enhance and increase functionality, add intelligence to the electric system, and drive transformative change.

The following table lists advancement investments to drive grid modernization and indicates which of the five grid modernization attributes each investment supports. See Appendix A for a brief description of each of the Advancement Programs, Projects and Pilots.

Grid Mod Investment - Advancement	Safe	Clean	Reliable	Resilient	Smart & Flexible
Substation SCADA		✓	✓	✓	✓
Distribution Automation - FLISR			✓	✓	✓
Transmission Automation			✓	✓	✓
Conservation Voltage Reduction (CVR) and Volt-VAR Optimization (VVO)		✓			✓
Advanced Metering Infrastructure (AMI)	SAFE	✓	✓	✓	✓
Advanced Distribution Management System (ADMS)	SAFE	✓	✓	✓	✓
Virtual Power Plant (VPP)		✓			✓
Distributed Energy Resource Management System (DERMS)	SAFE	✓	✓	✓	✓
AMI Data Analytics		✓	✓		✓
Data Lake and Analytics		✓	✓		✓
Geospatial Load Forecasting		✓	✓	✓	✓
Hosting Capacity Analysis Tool, Map, and Enhanced Interconnection Portal		✓			✓
Fault Circuit Indicators			✓		✓
Microgrid Demonstrations		✓	✓	✓	✓
Circuit Enablement – DERs and Microgrids		✓	✓	✓	✓
Circuit Enablement – Transportation Electrification		✓			✓

7. Supporting Activities

Grid Modernization requires continual evaluation and improvement of our work practices, processes and systems. PSE has initiated development of business capabilities that allow us to identify and integrate new technologies, stakeholder interests, and workforce advancements. These new approaches are further detailed as follows.

7.1 Integrating and Expanding Delivery System Planning

With a renewed focus on comprehensive energy planning, PSE has developed a delivery system planning (DSP) framework that benefits customers by identifying the best options to proactively move PSE toward a reliable, resilient, clean energy future. The cross departmental delivery system planning model and capabilities brings internal and external stakeholders of PSE together in a coordinated manner to achieve this. The operating model includes engagement of teams across PSE, addressing non-wired and hybrid solutions to meet system needs, with an eye towards continuous improvement.

Specific processes are in place to identify and evaluate new technology solution alternatives to solve planning needs, and tools and templates have been created to help approach new technology evaluation and integration. An internal Grid Modernization Emerging Technology Council is testing these new tools and templates with ongoing pilot projects. Tasks include more thorough documentation during new technology development to facilitate more-seamless integration of new technology into our routine business processes.

The DSP operating model and process changes are part of PSE's Grid Modernization vision and roadmap and they go hand in hand with load forecasting, Integrated Resource Planning (IRP), and new customer and product designs. Details of the DSP Model are contained in Appendix B.

7.2 Broadening Knowledge and Input through a Changed Approach to Stakeholder Engagement

Grid Modernization allows us to revisit our approach to engage different audiences. To solicit input and thought sharing, we can look to reaching beyond our traditional stakeholder groups and generate engagement with interested parties through focus groups, open community meetings, and targeted community organizations, amongst other communication tools, to learn about possibilities and identify new approaches that we are less likely to develop independently.

Public engagement and participation throughout the 2021 and 2022 IRP cycle considered and integrated delivery system planning more intentionally than previous cycles. While Delivery System Planning has been a chapter in previous IRPs and has been a topic at least once in each engagement cycle, its connection to the larger outcome of the IRP was less clear. Current draft IRP rules, along with RCW 19.280.100, bring greater definition to how a robust delivery system can fulfill resource needs delivered by distributed energy resources, including technologies such as batteries and demand response. Connecting various engagement processes of the IRP and Clean Energy Action Plan, and DER planning will help interested parties provide input and feedback with the greatest efficiency.

Still, we will seek to do more. Diversity, equity, and inclusion is a major value in this process. Full consideration for a representative audience is a must, as well as seeking input in various ways that different audiences are comfortable with. Equity considerations in how new resources are designed, acquired and delivered are included in our implementation planning to ensure all customers benefit.

LEVERAGE INSIGHTS FROM THE EQUITY ADVISORY GROUP

The members of the community-based Equity Advisory Group (EAG) that advise us on our Clean Energy Implementation Plan (CEIP) addressing the Washington Clean Energy Transformation Act (CETA) and share perspectives from their experiences related to environmental justice, Tribal interests, highly impacted communities, vulnerable populations, social services and affordable housing, which can inform thoughts on modernizing the grid.

DEVELOP CUSTOMER PARTNERSHIPS

PSE has focused on the customer and developing greater opportunities for customer partnerships. In 2020 PSE developed an intake process to help initiate collaborative opportunities. This process supports the evaluation of customer initiated partnership opportunities. The Tenino Microgrid project is an example of a customer partnership that increases resilience in the Tenino community while allowing PSE to demonstrate new technical capabilities.

The Washington State 2021 Clean Energy Strategy provides additional context for partnership opportunities. The strategy recommends development of resources for expanded outreach, technical assistance and education for community efforts. Potential partnership opportunities for PSE could include specific programs for Tribal energy projects, development of community resilience hubs and energy districts, and clean energy projects that benefit agricultural communities.

7.3 Identifying Skills to Transition to the Future

PSE evaluated workforce readiness to operate a modern grid. The evaluation consisted of three components -- Smart Grid Skill Sets, Knowledge Transfer and Training Plans, and Organizational Responsibilities. We are future-proofing skill sets of the workforce by identifying core skills essential to sustaining critical functions, as well as skills needed for future work, and enabling skills growth through people planning processes, training plans, and supportive labor agreements.

Using the Grid Modernization portfolio of work, PSE has identified near-term skill sets and competencies required for technology deployment and systems support. From this we are developing knowledge transfer and training plans and defining organizational responsibilities.

Of concern are labor shortages in skilled craft occupations and a desire for development of a diverse workforce representative of the communities we serve. Specific hiring challenges are line workers, technicians and electricians. PSE has built partnerships with two-year college programs for collaborative training programs and apprenticeships.

Apprenticeship participation and employee retention is key as we face upcoming retirements of knowledgeable staff in both technical and craft positions. Related to this is workforce succession planning. Expanding career development opportunities for technical and craft workers may help to reduce turnover, delay retirements, and control recruiting and training costs.

7.4 Organizational Intersections

Grid Modernization coordinates strategies and programs in other organizations within PSE. This approach creates an enterprise view of the cross-functional activities that all support PSE's vision to be our customers' clean energy partner of choice.

Listed below are some of the key ongoing programs that create physical, digital, and institutional infrastructure supporting grid modernization objectives and are foundational to the success of much of the Grid Modernization Strategy.

CYBERSECURITY AND PRIVACY: While pursuing our grid modernization strategy, PSE places a strong focus on cybersecurity and privacy. PSE applies due diligence across the enterprise to ensure risks are consistently addressed and mitigated in alignment with a rapidly changing security landscape and privacy requirements. PSE utilizes a variety of industry standards and policies to measure our maturity, with each standard providing a unique perspective on security and privacy. As critical infrastructure technology becomes more complex, it becomes crucial for PSE to adapt and mature cybersecurity practices and programs that allow and do not overly restrict ability of 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 cybersecurity protocols meet or exceed PSE's expectations and requirements.

As we assess cybersecurity for Distributed Energy Resources (DER) we aim to develop cybersecurity best practices, practical management approaches, and reference architectures to protect critical OT systems from risks emerging from integration of multi-party systems. We seek to understand and develop tools and guidelines for DER device security that range from large-scale connected environments to the component level. We continue to investigate potential cybersecurity concerns and solutions for automated demand response and end-use technologies.

We also realize the importance of Cloud Security for Real-Time Systems. As cloud applications mature and offer increasing value propositions, questions about security risks, security architectures, and regulatory requirements must be asked. We are reinforcing changes in cloud security to support this strategic shift in the use of the cloud.

DATA GOVERNANCE: PSE's Data Governance team manages decision rights over data in order to derive the most value from this corporate asset. It includes managing the integrity, quality, and usage of data during its lifecycle. Business and technology groups are involved in the decisions that affect data in order to ensure it is reliable, consistent, and complete. Data governance supports Grid Modernization by creating access and consistency across many data sources.

TELECOMMUNICATIONS: PSE's telecommunications infrastructure supports business and grid mod capabilities with a validated, flexible, and high security environment. PSE is upgrading wireless and fiber infrastructure and leveraging the AMI network to support current operational technologies, as well as new technologies.

8. Measureable Outcomes

A key to understanding the progress and impacts of the Grid Modernization effort is defining and measuring results. Investments will have direct correlation to benefits that a modern grid provides, such as operational efficiency and customer service improvements. PSE has established seven primary metrics to measure the progress of the Grid Modernization Strategy for each of the key grid characteristics, and continues to explore appropriate targets for each that reflect a future state of the electric grid that meets ongoing and emerging needs.

Metric	Description	2030 Target	Grid Attribute(s) Measured			
			Resilient	Reliable	Smart & Flexible	Clean
1	Percent of customers with automatic backup service	**>55%** of customers	✓	✓		
2	Percent of distribution system having SCADA	**>85%** distribution devices	✓	✓	✓	
3	System Average Interruption Duration Index (SAIDI)	**<121** minutes		✓		
4	System Average Interruption Frequency Index (SAIFI)	**<1.04** interruptions		✓		
5	Distribution Energy Resource (DER) Integration	**> 634** MW of DERs			✓	✓
6	Voltage Reducation energy savings	**>60** GWh energy savings				✓
7	Electric Vehicles (EVs) Enabled	**>100,000** EVs				✓

Metric 1: Percent of Customers with Automatic Backup Service

This metric counts the percent of PSE customers that benefit from automated distribution FLISR capabilities as well as automated islanding from DERs. A higher percentage means more customers will experience improved reliable service from a resilient grid.

The metric is calculated by summing all customers on distribution circuits that can be automatically restored from a backup source during an interruption divided by the total number of customers in PSE's service territory. Note that customers do not have to be guaranteed restoration under all circumstances to be counted. If the system is designed to pick up some set of customers for at least one scenario involving an interruption of service, then those customers are counted.

Target for 2030: greater than or equal to 55%.

The target is based on the current pace and planned progress of FLISR and islanding capability implementation as well as the proportion of the system where automatic backup service is feasible.

Metric 2: Percent of Distribution System Having SCADA

This metric counts the percent of distribution protective devices serving customer load that are visible and remotely controllable via SCADA. A higher percentage indicates a greater portion of the system can be monitored and controlled to adjust to changing circumstances resulting in greater reliability, resiliency and flexibility. A device must have real time remotely visible information from field sensors available in DMS, show status (open/closed), and include remote control capability (open/close). Devices include all PSE owned in-service distribution breakers and distribution line reclosers. This excludes spares, bus ties and other devices not directly serving customers. Most transmission and generation breakers and circuit switchers already have SCADA and are excluded from this metric.

The metric is calculated by dividing the sum of all devices included in the above definition with visibility and control in EMS or ADMS and dividing by the sum of all devices included in the above definition on PSE's system.

Target for 2030: greater than or equal to 85%.

The target is based on the current pace of SCADA implementations, the planned progress of SCADA implementations and the proportion of the system where SCADA is feasible.

Metric 3: System Average Interruption Duration Index (SAIDI)

SAIDI measures the average customer experience with respect to interruption duration per year. It is measured in minutes with a higher number of minutes reflecting a greater average total duration of interruptions and therefore a lower level of reliability. This measure excludes Major Event Days (MEDs) which prevents extreme events from skewing the data such that progress is obscured.

The metric is calculated by dividing the sum of customer minutes of interruption, excluding days that exceed the MED threshold, by the total number of customers served as defined by the IEEE 1366-2012 standard.

Target for 2030: less than or equal to 121 minutes.

The target is based on planned reliability work and comparison of what level of reliability is expected and feasible with respect to benchmarks such as the IEEE PES DRWG annual reliability survey.

Metric 4: System Average Interruption Frequency Index (SAIFI)

SAIFI measures the average customer experience with respect to interruption frequency per year. It is measured as number of interruptions with a higher number reflecting a greater average number of interruptions and therefore a lower level of reliability. This measure excludes Major Event Days (MEDs) which prevents extreme events from skewing the data such that progress is obscured.

The metric is calculated by dividing the sum of customer interruptions, excluding days that exceed the MED threshold, by the total number of customers served as defined by the IEEE 1366-2012 standard.

Target for 2030: less than or equal to 1.04 interruptions.

The target is based on planned reliability work and comparison of what level of reliability is expected and feasible with respect to benchmarks such as the IEEE PES DRWG annual reliability survey.

Metric 5: Distributed Energy Resource (DER) Integration

This metric calculates the total DER nameplate power connected to the system as well as the total contracted reduction in demand (demand response) connected to the system. It is measured in MW, with a higher number associated with a cleaner and more flexible grid. For this metric, DERs can include small generation sources such as solar as well as energy storage technologies and demand response.

The metric is calculated by summing the nameplate or contractually stated demand reduction of all eligible DERs.

Target for 2030: greater than or equal to 634 MW.

The target is based on the current pace and planned progress of DER enablement and integration.

Metric 6: Voltage Reduction Energy Savings

This metric determines the amount of energy savings from the Conservation Voltage Reduction (CVR) program and future Volt-Var Optimization (VVO) program. It is measured in MWh with a higher number being associated with a reduction in demand and a cleaner grid. This metric does not distinguish between various methods of control or devices used to manage voltage. Any intentional reduction in voltage for the purpose of saving energy can be included in the calculation.

The metric is calculated by summing up the measured energy savings of all CVR/VVO implementations. The number represents the difference in energy used by a system with CVR or VVO compared to the same system without CVR or VVO.

Target for 2030: greater than or equal to 60 GWh.

The target is based on the planned rate of CVR/VVO implementation and the average expected benefits.

Metric 7: Electric Vehicles (EVs) Enabled

This metric determines the number of electric vehicles registered in PSE's service territory. A greater number of electric vehicles corresponds to a greater amount of energy transitioning from fossil fuels to cleaner sources. Grid modernization investments support this effort by identifying where EVs are likely to be connected to the grid and pro-actively upgrading the system to accommodate the additional load and complexity that comes with increasing numbers of EVs.

The metric is calculated by counting the number of electric vehicles registered in counties within PSE's territory.

Target for 2030: enable 100,000 EVs.

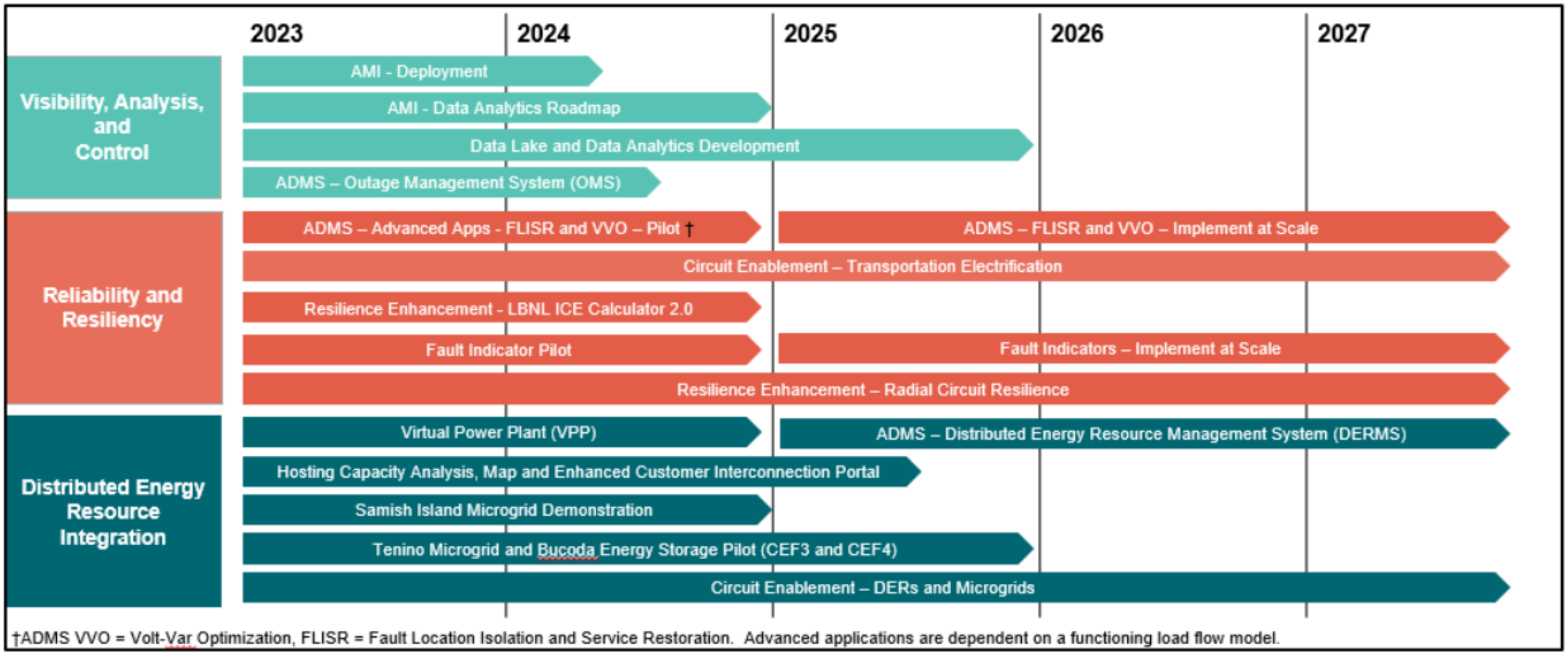
This target is based on future projections assuming current trends continue.

9. Roadmap

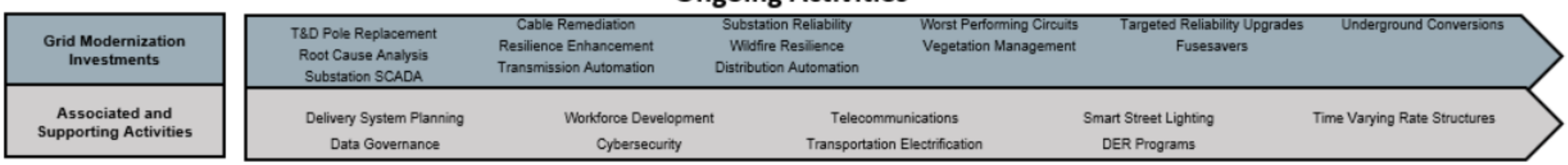
The Grid Modernization roadmap shows the programmatic approach to advancing grid technologies in three categories: Visibility, Analysis, and Control; Reliability and Resiliency; and Distributed Energy Resource Integration.

Other Grid Modernization investments and associated supporting activities are shown below the roadmap, as they continue on an ongoing basis through coordinated planning across the enterprise.

GRID MODERNIZATION ROADMAP



Ongoing Activities



Appendix A – Grid Mod Investment Descriptions

Grid Sustainment: Continuing Investments

In addition to developing new technologies, PSE is committed to supporting and maintaining our existing infrastructure to drive reliability and resiliency goals. Investment in monitoring, assessing, and maintaining our existing equipment is a low-cost way to extend the life of the electrical grid and drive reliability and resiliency goals.

Pole Replacement	Pole Replacement is focused on the structural integrity of the overhead electric system in order to optimize equipment lifecycle and effectively mitigate system risks in alignment with industry best practice, the NESC, USDA Rural Utilities Service.
Cable Remediation (CRP)	CRP is focused on remediating primarily direct buried bare concentric neutral cables that have a trended probability of failure, of which high-molecular weight (HMW) cable type is the worst offender.
Substation Reliability	Substation Reliability is focused on the proactive replacement of major substation assets that are in poor condition to reduce the risk and cost of unplanned outages due to equipment failure.
Targeted Reliability Upgrades	Targeted Reliability Upgrades focuses on circuits that have the greatest benefit-cost ratios which typically have a high number of customers. Improvements include Overhead (OH) or Underground (UG) Rebuilds, Tree Wire Upgrades, UG Conversion, Feeder Ties and other Reliability improvements.
Worst Performing Circuits (WPC)	WPC are circuits that have historically had poor reliability performance year after year with high customer minutes interruptions (CMI) and high circuit SAIDI and SAIFI, typically in more rural areas with lower number of customers. PSE is focused on 135 circuits presently in a multi-year effort to make targeted investments to improve the performance of these circuits. Different reliability strategies are applied to the WPC circuits, including tree wire, underground conversions, overhead rebuilds, adding new feeder ties and distribution automation and more recently considering non-wire alternatives, i.e., energy storage solutions until the circuit improves by 50%.
Resilience Enhancement	Resilience efforts are focused on low probability, high consequence risks that take significant efforts to understand and mitigate along with ongoing system-wide asset health issues that make the electrical system more susceptible to destabilization. Included in these programs are drone based LiDAR and IR scanning, transformer health monitoring and microgrid systems that can serve customers during widespread interruptions.

Root Cause Analysis	Root Cause Analysis is a process that brings a holistic approach to improving PSE's reliability indices through robust outage investigation, strategic culture assessment, and application of comprehensive solutions.
Distribution Reclosers	Distribution Reclosers are specialized protective devices that sectionalize and reduce the number of customers impacted by a permanent fault on the main line feeder and reduce the frequency of sustained power interruptions by quickly tripping to clear temporary faults and restore power following a momentary outage. Distribution Automation leverages reclosers extensively.
Fusesavers	Fusesavers is a technology focused on replacement of existing fuses (100T) on the electric distribution system with specialized protection devices that trip quickly to reduce the frequency of sustained power interruptions by quickly tripping to clear temporary faults and restore power following a momentary outage. – Strategic deployment of Fusesavers will reduce CMI, SAIDI, SAIFI, and CEMI by shortening some outages from sustained outages that require serviceman deployment to momentary outages with no personnel dispatch required.
Wildfire Resilience	Wildfire Resilience is focused on preventing and mitigating wildfire impact relative to size, frequency, and destructive effect. PSE's wildfire mitigation plan improves situational awareness, assessment of the wildfire risk, implementation of mitigation solutions, and development of operational processes to ensure communication and safety.

Grid Advancement: Developing Technologies

This section provides brief definitions/explanations of the technology advancement investments currently under development to drive grid modernization. These technologies enhance and increase functionality, add intelligence to the electric system, and drive transformative change.

Substation SCADA	Substation Supervisory Control and Data Acquisition (SCADA) will bring capabilities that enable data collection and communication between equipment in order to function automatically or to be controlled remotely if needed. SCADA implementation includes upgrades typically to the substation breakers on the 12.5kV distribution system and the installation of controllers, relays, sensors, software and IT (Information Technology) upgrades for communication. and
Distribution Automation - FLISR	Distribution automation is the addition control schemes that operate digital sectionalizing devices to reduce a power outage as a result of a faulted portion of a distribution line to impact the least amount of customers, reconfiguring a circuit in milliseconds. Fault Location, Isolation, and Service Restoration (FLISR) is the advanced control algorithm that networks groups of switches on a feeder to vastly improve the reliability of utility delivered power by sectionalizing outages.

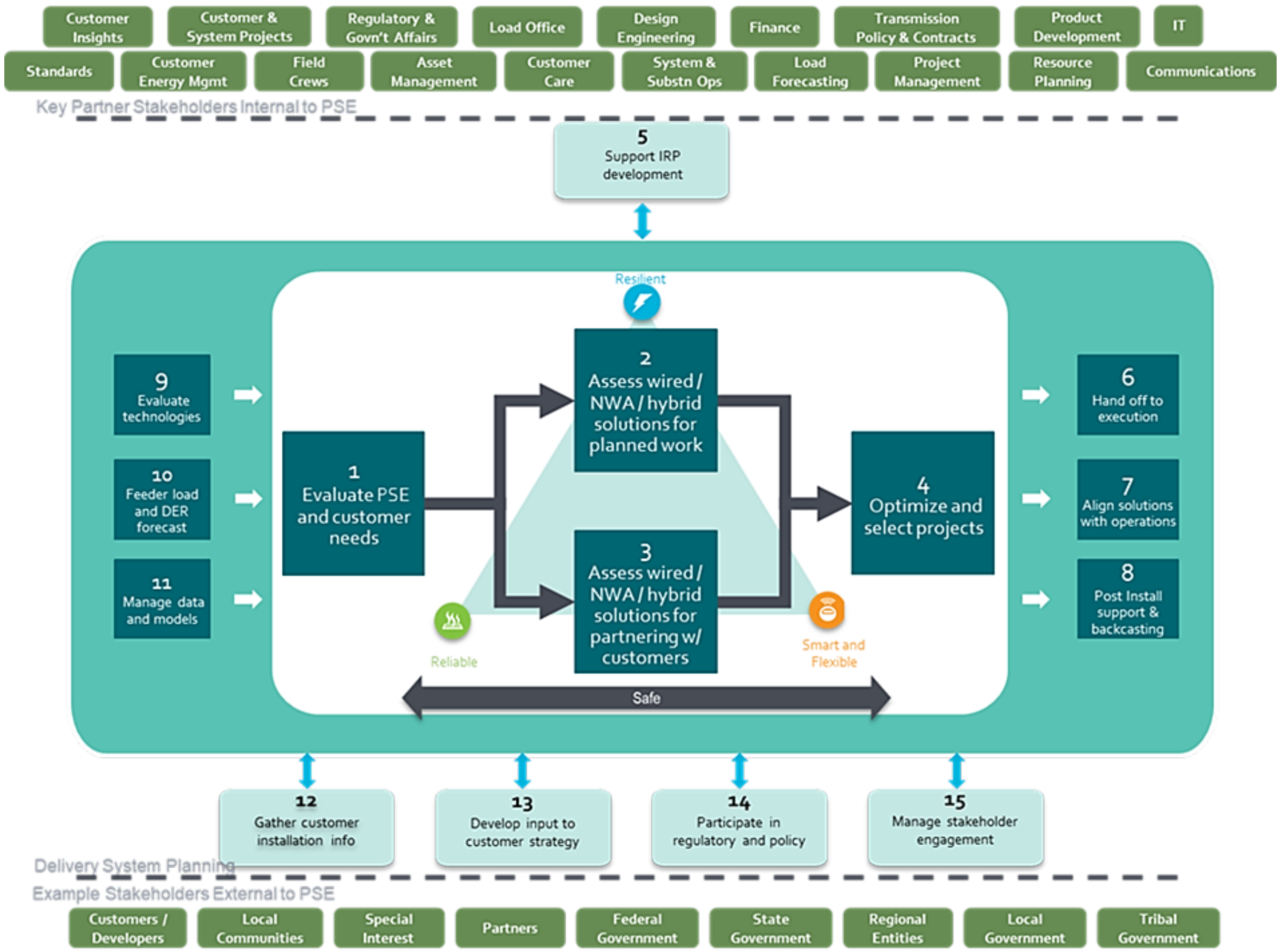
Transmission Automation	Transmission Automation is the enhancement of control schemes that operate digital sectionalizing devices to reduce a power outage as a result of a faulted portion of a transmission line to impact the least amount of customers, reconfiguring a circuit in milliseconds. This improves resiliency following transmission line faults.
Conservation Voltage Reduction (CVR) and Volt-VAR Optimization (VVO)	CVR is the adjustment to substation transformer and line regulator voltages such that customers operate in the lower end of the acceptable service voltage range. This increases the efficiency of equipment and saves energy. When combined with integrated reactive power management, referred to as Volt-VAR Optimization, it can provide more energy savings.
Advanced Metering Infrastructure (AMI)	AMI is the current standard for metering technology for both gas and electric meters, replacing the end-of-life Automated Meter Reading (AMR) system. It uses two-way communication and on-board memory to send more detailed and accurate meter data through a secure wireless network. AMI is a foundational technology for Grid Modernization because it enables enhanced grid visibility and energy and operational data that supports system planning and advanced grid operations.
Advanced Distribution Management System (ADMS)	ADMS is a computer-based, integrated platform that provides the tools to monitor and control the distribution network in real time. ADMS is a foundational platform for Grid Modernization as it enables several advance operational tools such as VVO, FLISR, and DERMS.
Virtual Power Plant (VPP)	A VPP is a software platform that provides visibility and control of distributed energy sources to deliver system capacity. The VPP will enable monitoring, aggregation, forecasting, dispatch and management of DERs to meet resource capacity needs.
Distributed Energy Resource Management System (DERMS)	A DERMS is a platform by which DERs can be effectively monitored, managed, capabilities enabled, and optimized. When DERMS is integrated with ADMS, it will allow full visibility to the system operator and allow for safe and optimal dispatch coordinated with other operations activities.

AMI Data Analytics	AMI Data Analytics is an intentional effort to develop ways to apply the additional and improved data from AMI meters into benefits for our customers such as: • Aggregated Customer Data to provide more granular and timely usage data to empower customers to understand and manage their energy consumption • Load Disaggregation to better understand customers' energy use patterns • Improved outage location to aid restoration and improve reliability • Distribution Asset Health assessment
Data Lake and Analytics	Data Lake and Analytics is the collection of and the accessibility to disparate data such as DER asset information, near real-time metering data, customer program participation, and detailed electric system asset information to enable new system operations and business processes based in analytics. Advanced operational and planning capabilities require significant enhancements to data availability and granularity.
Geospatial Load Forecasting	Geospatial and econometric load forecasting tools enable PSE to predict load and power changes, where these loads will occur, and how distributed generation affects the load shape. This will support the development of non-wires alternatives and DER optimization.
Hosting Capacity Analysis Tool, Map, and Enhanced Interconnection Portal	Hosting Capacity Analysis (HCA) and presentment enables customers, vendors, and planners to know where distributed energy resources are valuable additions to the operation and efficiency of the grid. When HCA results are made visible to customers and developers, it will result in a more transparent process and faster interconnection of DERs.
Fault Circuit Indicators	Fault Circuit Indicators (FCI) provide local and remote visibility of when downstream faults occur on the grid. As more devices are deployed on our grid, there will be a more efficient dispatch of crew resources, leading to faster restoration times. These FCIs also provide improved situational awareness for crews and system operators and may also support state estimation and advanced applications within ADMS.
Microgrid Demonstrations	Microgrids are self-contained 'islands' of balanced generation and load that can operate independently at times when the larger electrical system is offline. They can provide high reliability & resiliency for essential services even during major outage events. PSE is conducting demonstration projects involving microgrids and DER integration to test how these strategies can improve reliability and resiliency in places such as highly impacted communities, transportation hubs, emergency shelters and areas at risk for isolation during significant weather events or wildfires.

Circuit Enablement – DERs and Microgrids	Circuit enablement to advance DERs and microgrids proactively improves electric infrastructure to increase hosting capacity equitably. As the DER portfolio scales, the peak capacity output for DERs on a circuit will be constrained by existing grid infrastructure due to high amounts of reverse power flow. This is a prevalent condition in 56% of distribution circuits (or 179 distribution substations) where low transformer loading conditions exist. Moreover, primary and/or secondary conductors on distribution feeders pose chokeholds to DER capacity in both aggregated/non-aggregated instances. Voltage imbalances caused by DER production onto the grid impacts reliability, which in turn limits available hosting capacity.
Circuit Enablement – Transportation Electrification	Circuit enablement in anticipating more EV's on circuits will avoid reactive upgrades due to power quality. This aligns with PSE's Transportation Electrification Plan and includes distribution transformer upgrades for impacted circuits, and updating standards to address future increased loads.

Appendix B – Delivery System Planning Operating Model

The Delivery System Planning process is comprised of 15 capabilities. The process segments and details are explained more clearly here:



Delivery System Planning Capabilities

1	Evaluate and prioritize system planning needs	The traditional planning process that analyzes and prioritizes reliability and capacity needs. This capability includes establishing criteria for the solution based on Transmission and Distribution Planning Guidelines.
2	Assess wired/NWA solutions for inclusion into planned work	Use the results of the alternative (NWA, DER, OT, etc.) technologies capability and prioritized planning needs to develop traditional wired solutions, NWA solutions, and/or hybrid solutions combining of both and identify the best alternative(s).
3	Assess Wired/NWA solutions for partnering with customer planned work	Use the results of the alternative (NWA, DER, OT, etc.) technologies capability to work with some or all customers to both influence their NWA decisions but also to find ways to collaborate with them to incorporate solutions beneficial to both
4	Optimize investment decisions & select projects	The process of determining the best investment decisions considering costs and benefits of all alternatives and finalizing the set of projects within the budget. The current process and tools may be used in different ways such as project alternative comparison.
5	Support IRP Development	The integration and monitoring of the planning process with the IRP process with inputs and outputs associated with ensuring that (1) non wires alternatives are considered (2) DER implementations by customers are considered and (3) changes to the grid required to handle 2-way power flow when DER penetration requires it.
6	Hand off to execution team for implementation	The capability to define the package of information required by the execution team to implement the project. Planning will also stay involved during the construction phase to ensure that the implementation is as planned.
7	Align solution with operations	The capability to interact with operations in the front-end and the back-end of the planning effort. In the front-end, Operations will provide key requirements that need to be addressed during planning. On the back-end, planning will provide the operating scenarios under which the planned changes can be operationalized.
8	Post installation management and support	This capability is the ongoing process of supporting a project after go-live to ensure that the benefits are realized. Feedback loop should be established to incorporate lessons learned. This capability assumes that root cause analysis is performed when major incidents occur.
9	Evaluate and incorporate alternative technologies	Assess different alternative (NWA, DER, OT, etc.) technologies available in the industry including automation, software systems, DER technologies and other NWA solutions to confirm their applicability (cost, performance, and suitability) to solve one or more problems identified during the planning process.
10	Feeder/zip code level load and DER forecast	Forecasting load and DER/NWA kW, kWh and hourly load profile at the feeder level, including variability and information on end uses. This capability is also about tracking the roadmap for changes to DER penetration and defining mechanisms on how to track it over time.
11	Manage data and data models	This is a foundational requirement for all grid modernization efforts. Manage and track data and models associated with forecasting and other related planning tasks. Tasks involve identifying data required, their sources, their maintenance, and their stewardship. PSE Standards are incorporated in planning input data.
12	Gather customer installation information	Customer installation of DERs, NWA and wired solutions require PSE coordination. However, this information is not always available to the planning team. This is a new capability to define a system that will collect customer installation information (including C&I and residential) and disseminate to all.
13	Develop inputs to customer strategy	Identify potential DER/NWA and even wired product options for consideration by customers.
14	Monitor, evaluate and incorporate regulatory and policy developments	The capability to monitor and track regulatory and policy developments and understand the impact of these changes to planning, both directly and indirectly through other areas of the utility.
15	Manage stakeholder engagement	Defining the need to engage with stakeholders, to listen and factor in their input, and to increase transparency through a combination of meetings, dissemination of the information and regulatory interactions.

Acronyms

ADMS	Advanced Distribution Management Systems
AMI	Advanced Metering Infrastructure
BESS	Battery energy storage system
BTM	Behind-the-meter
DER	Distributed Energy Resources
CEF	Clean Energy Fund (WA Dept of Commerce)
CVR	Conservation Voltage Reduction
DERMS	Distributed Energy Resource Management System
DG	Distributed generation
DMS	Distribution Management System
DR	Demand Response
DSM	Demand-side management
EE	Energy efficiency
EMS	Energy Management System
EPRI	Electric Power Research Institute
ESS	Energy storage system
EV	Electric Vehicle
FERC	Federal Energy Regulatory Commission
FLISR	Fault location, isolation, and service restoration
FTM	Front of-the-Meter
IEEE	Institute of Electrical and Electronics Engineers
GIS	Geographic Information System
IT	Information Technology
kW	Kilowatt
MW	Megawatt
NREL	National Renewable Energy Laboratory
NWA	Non-wires alternative(s)
NWS	Non-wires solution
OMS	Outage Management System
OT	Operational Technology
PV	Photovoltaic (solar power)
PNNL	Pacific Northwest National Lab
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SME	Subject matter expert
TE	Transportation Electrification
T&D	Transmission and Distribution
TOU	Time of Use rates
V2G	Vehicle-to-grid
VVO	Volt/VAR optimization
VPP	Virtual power plant

Glossary

A

Advanced Distribution Management System (ADMS): The software platform that supports the full suite of distribution management and optimization. An ADMS includes functions that automate outage restoration and optimize the performance of the distribution grid. ADMS functions being developed for electric utilities include fault location, isolation and restoration; volt/volt-ampere reactive optimization; conservation through voltage reduction; peak demand management; and support for microgrids and electric vehicles.

Advanced Metering Infrastructure (AMI): Refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and a service provider, and head-end data reception and management systems that make the information available to the service provider.

Advanced inverter: A power electronics device that transforms variable direct current to alternating current and that provides functions such as reactive power control and voltage and frequency ride-through responses to improve the stability, reliability, and efficiency of the distribution system.

C

Capacity: The maximum output (generation) of a power plant. Capacity is typically measured in a kilowatt (kW), megawatt (MW), or gigawatt (GW) rating. Rated capacity may also be referred to as "nameplate capacity" or "peak capacity." This may be further distinguished as the "net capacity" of the plant after plant parasitic loads have been considered, which are subtracted from "gross capacity."

Conservation Voltage Reduction (CVR): An operating strategy of the equipment and control system used for VVO that reduces energy and peak demand by managing voltage at the lower part of the required range.

Curtailment: A reduction in the output of a generator from what it could otherwise produce given available resources.

D

Demand response: Voluntary (and compensated) load reduction used as a system reliability resource. Demand response allows utilities to cycle certain loads on and off in exchange for financial incentives.

Demand-side management (DSM): The modification of consumer demand for energy through methods such as financial incentives and behavioral change. The goal of DSM is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as nighttime and weekends. Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and/or power plants for meeting peak demands.

Distributed Energy Resources (DER): A source or pool of power that is located on the distribution system, any subsystem thereof, or behind a customer meter. These resources may include, but are not limited to, electric storage resources, distributed generation, thermal storage, and electric vehicles and their supply equipment.

Distributed Energy Resources Management System (DERMS): A software platform that is used to organize the operation of the aggregated DER within a power grid.

E

Energy storage system (ESS) Technologies: capable of storing electricity generated at one time and for use at a later time. Storage technologies include batteries, pumped hydroelectric power, compressed air storage, thermal storage, and others. Also *Storage*

F

Fault: An event occurring on an electric system such as a short circuit, a broken wire, or an intermittent connection.

Fault Location Isolation and Service Restoration (FLISR): Distribution automation system which detects and responds to faults in order to minimize the number of customers affected by a distribution system outage.

Flexibility (operational): The ability of a power system to respond to changes in electricity demand and supply.

Flexible generation: The ability of the generation fleet to change its output (ramp) rapidly, start and stop with short notice, and achieve a low minimum turn-down level.

Frequency response: The ability of generation (and responsive demand) to increase output (or reduce consumption) in response to a decline in system frequency and decrease output (or increase consumption) in response to an increase in system frequency. Primary frequency response takes place within the first few seconds following a change in frequency. Secondary frequency response (also known as regulating reserve) takes place on a timescale of minutes (or faster) following a disturbance.

G

Grid Architecture: A discipline with roots in system architecture, network theory, control engineering, and software architecture, all of which we apply to the electric power grid. An architectural description is a structural representation of a system that helps people think about the overall shape of the system, its attributes, and how the parts interact.

Grid congestion: The event that occurs when actual or scheduled flows of electricity over a line or piece of equipment are constrained below desired levels.

Grid integration of renewable energy: The practice of power system planning, interconnection, and operation that enables efficient and cost-effective use of renewable energy while maintaining the stability and reliability of electricity delivery.

I

Interconnection: An independent electricity system network that operates at a particular frequency. An interconnection consists of one or more balancing area authorities that balance demand and generation within certain geographic areas of the interconnection.

L

Line capacities: The maximum and minimum voltage, current, frequency, real and reactive power flows on individual equipment under steady state, short-circuit and transient conditions, as permitted or assigned by the equipment owner.

Load: An end-use device or customer that receives power from the electric system.

Load forecast: A prediction of future demand. For normal operations, daily and weekly forecasts of hour-by-hour demand are used to develop generation schedules that ensure sufficient quantities and types of generation are available when needed.

Load shedding: The reduction of system demands by systematically and in a predetermined sequence interrupting the load flow to major customers and/or distribution circuits, normally in response to system or area capacity shortages or voltage control considerations.

M

Microgrid: A microgrid is a self-sufficient energy system that serves a discrete geographic footprint, such as a college campus, hospital, business center, or neighborhood. Within microgrids are one or more kinds of distributed energy (solar panels, wind turbines, combined heat & power, generators) that produce its power.

N

Net load (net demand): Demand that must be met by other generation sources if all wind and solar power is consumed.

O

Operational flexibility: *See Flexibility (Operational)*

Operational Technology: Hardware and software that detects or causes a change, through the direct monitoring and/or control of industrial equipment, assets, processes and events." 11 The term has become established to demonstrate the technological and functional differences between traditional IT systems and Industrial Control Systems environment, the so-called "IT in the non-carpeted areas"

P

Peak load: 1. The highest hourly demand within a Balancing Area occurring within a given period (e.g., day, month, season, or year). 2. The highest instantaneous demand within the Balancing Area.

Photovoltaic: Solar cells, also called photovoltaic cells, convert sunlight directly into electricity. Photovoltaics (often shortened as PV) gets its name from the process of converting light (photons) to electricity (voltage), which is called the photovoltaic effect.

R

Rated capacity: The maximum capacity of a generating unit.

Reactive power: The portion of electricity that establishes and sustains the electric and magnetic fields of alternating-current equipment. Reactive power must be supplied to most types of magnetic equipment, such as motors and transformers. It also must supply the reactive losses on transmission facilities.

S

Storage: See *Electric energy storage*

Supervisory Control and Data Acquisition (SCADA): A system of remote control and telemetry used to monitor and control the transmission and distribution system including substations, transformers and other electrical assets.

System: A combination of generation, transmission, and distribution components.

System Average Interruption Duration Index (SAIDI): A description of the length of time all customers would have been out of power if the total number of hours out of service in a year's time were to be shared, and it is typically measured in minutes.

System Average Interruption Frequency Index (SAIFI): A measurement of the average frequency or number of times customers experience a sustained interruption of service during a predefined period of time.

T

Transmission constraint: A limitation on one or more transmission elements that may be reached during normal or contingency system operations.

V

Variable renewable energy (RE): Electricity generation technologies whose primary energy source varies over time and cannot easily be stored. Variable generation sources include solar, wind, ocean, and some hydro generation technologies.

Virtual Power Plant (VPP): A Virtual Power Plant (VPP) is a software platform that provides visibility and control of distributed energy sources to deliver system capacity. A VPP enables monitoring, aggregation, forecasting, dispatch and management of DERs to meet resource capacity needs.

Volt/VAR optimization (VVO): A process of optimally managing voltage levels and reactive power to achieve more efficient grid operation by reducing system losses, peak demand or energy consumption or a combination of the three. The efficiency gains are realized primarily from a reduction in the system voltage.

Voltage: The difference in electrical potential between any two conductors or between a conductor and ground. Voltage is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors**.**

Voltage regulator: A device designed to maintain voltage levels within acceptable limits.

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Revision Date	**Revision Description**
May 2023	Update document structure, roadmap and metrics
Dec 2021	Initial Document